44e Année 35e Volume

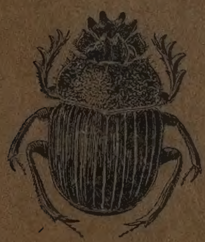
BULLETIN

DE LA

SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

anciennement :

Société Entomologique d'Egypte (1907-1921)
et *Société Royale Entomologique d'Egypte* (1922-1937)



FONDÉE LE 1er AOUT 1907

PLACÉE SOUS LE HAUT PATRONAGE DU GOUVERNEMENT EGYPTIEN
PAR DÉCRET ROYAL EN DATE DU 15 MAI 1923

LE CAIRE

IMPRIMERIE PAUL BARBEY

1951

SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

Les membres sont nommés par le Conseil sur la proposition de deux membres titulaires; ils doivent un droit fixe d'entrée de 20 piastres, et paient une cotisation annuelle de 100 piastres, celle-ci exigible à partir du 1er Janvier; ils reçoivent toutes les publications de la Société.

Les institutions publiques et les sociétés savantes peuvent être admises comme membres, aux mêmes charges et aux mêmes droits que les membres titulaires.

Les travaux destinés au Bulletin doivent être consignés au Secrétaire Général de la Société avant le 1er Mai, faute de quoi leur publication sera renvoyée à l'année suivante. Ils doivent être présentés dans leur forme définitive, dactylographiés (double interligne) sur le recto seulement des feuilles. Aucune indication typographique concernant les caractères à employer ne doit figurer sur le manuscrit, ce travail étant fait par les soins du rédacteur en chef.

Les références bibliographiques doivent comporter, dans l'ordre suivant le nom de l'auteur, ses initiales, la date de publication, le titre du travail, désignation de la publication et du volume, la pagination et les figures s y a lieu.

Les auteurs reçoivent gratuitement 50 tirés à part de leurs travaux toute quantité supplémentaire sera facturée au prix coutant.

Pour la correspondance administrative et scientifique, échanges de Publications, changement d'adresse et réclamations, s'adresser à Monsieur le SECRÉTAIRE GÉNÉRAL DE LA SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE, Boîte Postale N° 430, Le Caire.

BULLETIN

DE LA

SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

QUARANTE-QUATRIÈME ANNÉE

TRENTE-CINQUIÈME VOLUME

1951

44e Année 35e Volume

BULLETIN

DE LA

SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

anciennement :

Société Entomologique d'Egypte (1907-1921)
et *Société Royale Entomologique d'Egypte* (1922-1937)

FONDÉE LE 1er AOUT 1907

PLACÉE SOUS LE HAUT PATRONAGE DU GOUVERNEMENT EGYPTIEN
PAR DÉCRET ROYAL EN DATE DU 15 MAI 1923

LE CAIRE

IMPRIMERIE PAUL BARBEY

1951

Les opinions émises dans les publications de la Société sont propres à leurs auteurs. La Société n'en assume aucunement la responsabilité.

Date de parution et de distribution de ce Volume :
31 Décembre 1951.

Le Rédacteur en Chef :
A. ALFIERI

HAUTS PROTECTEURS
DE LA SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

Le Très Regretté Roi FOUAD Ier

et

Sa Majesté le Roi FAROUK Ier

BIENFAITEURS

1924

M. MOUSTAPHA MOURAD EL-SALANEKLI Bey, de Damanhour (Béhéra).

1925

S.E. EL-SAYED FATHALLAH MAHMOUD Pacha, de Rahmania (Béhéra); M. RIAD ABDEL-KAWI EL-GEBALI Bey, de Chebin-El-Kom (Menoufia); S.E. GEORGES WISSA Pacha, d'Assiout (Haute-Egypte); M. YEHIA KAWALLI Bey, de Minieh (Haute-Egypte); M. YACOUB BIBAWI ATTIA Bey, de Minieh (Haute-Egypte); S.E. HASSAN CHARAWI Pacha, de Minieh (Haute-Egypte); S.E. HABIB CHENOUDA Pacha, d'Assiout (Haute-Egypte); M. MOHAMED TEWFIK MOHANNA Bey, de Tewfikieh (Béhéra); M. HASSAN AHMED MOUSSA Bey, de Minieh (Haute-Egypte): M. LABIB BARSOUM HANNA Bey, de Minieh (Haute-Egypte); S.E. HASSAN MOHAMED EL-TAHTAWI Pacha, de Ghirgheh (Haute-Egypte); M. KASSEM OSMAN EL-LABBAN Bey, de Ghirgheh (Haute-Egypte); M. DORDEIR EL-SAYED AHMED EL-ANSARI Bey, de Ghirgheh (Haute-Egypte); M. BARSOUM SAID ABDEL-MESSIH Bey, de Minieh (Haute-Egypte); M. DORDEIR TAHA ABOU-GOUNEMA Bey, de Minieh (Haute-Egypte).

1926

M. MOHAMED RIFAAT EL-ROZNAMGY Bey

1927

M. le Dr. WALTER INNES Bey (décédé en 1937); M. le Dr. Avocat GIOVANNI FERRANTE (décédé en 1946).

1928

M. le Professeur HASSAN C. EFFLATOUN Bey, du Caire; M. HUGO LINDEMAN (décédé en 1937).

1932

M. ALFRED REINHART (décédé en 1935).

ORGANISATION ADMINISTRATIVE POUR L'ANNÉE 1951

Membres du Conseil

S.E. le Prof. MAHMOUD TEWFIK HIFNAOUI Pacha, *Président.*

M. le Prof. HASSAN C. EFFLATOUN Bey, *Vice-Président.*

M. MOHAMED SOLIMAN EL-ZOHEIRY Bey, *Vice-Président.*

M. ANASTASE ALFIERI, *Secrétaire-Général.*

M. le Dr. SAADALLAH MOHAMED MADWAR Bey, *Trésorier.*

M. le Prof. Dr. HAMED SELEEM SOLIMAN Bey.

M. le Prof. Dr. KAMEL MANSOUR Bey.

M. le Prof. Dr. H. PRIESNER.

M. ABD EL-MEGID EL-MISTIKAWY.

M. le Dr. MOHAMED SHAFIK Bey.

M. le Dr. MAHMOUD HAFEZ.

M. MAHMOUD HOUSNY.

Comité Scientifique

M. le Prof. HASSAN C. EFFLATOUN Bey, M. le Prof. Dr. HAMED SELEEM SOLIMAN Bey, M. MOHAMED SOLIMAN EL-ZOHEIRY Bey, M. le Prof. Dr. H. PRIESNER, M. le Prof. Dr. KAMEL MANSOUR, M. le Dr. SAADALLAH MOHAMED MADWAR Bey, M. le Dr. MAHMOUD HAFEZ, M. ANASTASE ALFIERI.

Censeurs

M. E. KAOURK et M. ELHAMY GREISS.

LISTE DES MEMBRES

DE LA

SOCIÉTÉ FOUAD Ier D'ENTOMOLOGIE

EN 1951

(Les noms des Membres Fondateurs sont précédés de la lettre F)

Membres Honoraires

1950 BERLAND (L.), Laboratoire d'Entomologie, Museum National d'Histoire Naturelle, 45 bis, Rue de Buffon, Paris (Ve), France.

1950 CHOPARD (Lucien), Professeur titulaire de la Chaire d'Entomologie du Museum National d'Histoire Naturelle, 45 bis, Rue de Buffon, Paris (Ve), France.

1924 EBNER (Prof. Richard), 3, Beethovengasse, Vienne (IX), Autriche.

1950 HALL (Dr. W.J.), Director of the Commonwealth Institute of Entomology, 41, Queen's Gate, Londres, S.W. 7, Angleterre.

1950 JEANNEL (Prof. Dr. René), Directeur du Museum National d'Histoire Naturelle, Laboratoire d'Entomologie, 45 bis, Rue de Buffon, Paris (Ve), France.

1950 MARSHALL (Sir Guy), 31, Melton Court, Onslow Crescent, Londres, S.W. 7, Angleterre.

1950 MUNRO (Prof. Dr. J.W.), Imperial College of Science and Technology, Field Station, Silwood Park, Sunninghill, Berks, Angleterre.

1950 NEAVE (Dr. S.A.), Mill Green Park, Ingatestone, Essex, Angleterre.

1929 PEYERIMHOFF DE FONTENELLE (P. de), 87, Boulevard Saint-Saëns, Alger, Algérie.

1908 PIC (Maurice), Les Guerreaux, par Saint-Agnan (Saône-et-Loire), France.

1950 Snodgrass (R.E.), Bureau of Entomology, United States Department of Agriculture, Washington, D.C., Etats-Unis d'Amérique.

1943 Uvarov (Dr. B.P.), Director Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, Londres, S.W. 7, Angleterre.

1950 Wigglesworth (Dr. V.D.), Zoological Laboratory, Downing Street, Cambridge, Angleterre.

F Willcocks (F.C.), « Brambles », Hurst Lane, Sadlescombe (near Battle), Sussex, Angleterre.

1950 Williams (Dr. C.B.), Rothamsted Experimental Station, Harpenden, Herts, Angleterre.

Membres Correspondants

1932 Alfken (J.D.), 18, Delmestrasse, Brême, Allemagne.

1950 Balachowsky (A.S.), Chef du Service de Parasitologie Végétale, Institut Pasteur, 25, Rue du Docteur Roux, Paris (XVe), France.

1950 Boursin (Ch.), 11, Rue des Ecoles, Paris (Ve), France.

(1950) F Chakour (Edgard), Pension Erlanger, 10, Rue Erlanger, Paris (XVIe), France.

1950 China (W.E.), British Museum (Natural History), Cromwell Road, Londres, S.W. 7, Angleterre.

1924 Hindle (Prof. Dr. Edward), Zoological Society of London, Regent's Park, London, N.W. 8, Angleterre.

1925 Kirkpatrick (Thomas Winfrid), The Imperial College of Tropical Agriculture, Trinidad, British West Indies.

1934 Koch (C.), c/o Transvaal Museum, Post Office Box N° 413, Prétoria, Afrique du Sud.

1929 Masi (L.), Museo Civico di Storia Naturale « Giacomo Doria », 9, Via Brigata Liguria, Genova (102), Italie.

1950 Richards (Dr. O.W.), Imperial College of Science and Technology, Prince Consort Road, Londres, S.W. 7, Angleterre.

1950 Séguy (E.), Laboratoire d'Entomologie, Museum National d'Histoire Naturelle, 45 bis, Rue de Buffon, Paris (Ve), France.

1950 Thorpe (Dr. W.H.), Department of Zoology, University of Cambridge, Downing Street, Cambridge, Angleterre.

1950 Vayssière (P.), Professeur d'Entomologie Agricole Coloniale, Museum National d'Histoire Naturelle, 57, Rue Cuvier, Paris (Ve), France.

Membres Titulaires

1913 Abaza Pacha (S.E. Fouad), Directeur Général de la Société Royale d'Agriculture, Boîte Postale N° 63, au Caire.

1951 Abd El-Aziz (Omar), 4, Maamal El-Baroud, Kasr El-Aïni, au Caire.

1944 Abdel Malek (Dr. Albert A.), Conférencier au Département d'Entomologie, Faculté des Sciences, Université Fouad Ier, Ghizeh (Orman), près le Caire.

1951 Abou El-Ezz (Anwar Mohamed), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1949 Afifi (Afifi Mahmoud), Démonstrateur au Département d'Entomologie, Faculté des Sciences, Université Fouad Ier, Ghizeh (Orman), près le Caire.

1950 Ahmed (Moustafa), 5, Sharia Haroun, Ghizeh (Orman).

1908 Alfieri (Anastase), Secrétaire Général et Conservateur de la Société Fouad Ier d'Entomologie, Boîte Postale N° 430, au Caire.

1938 Attia (Rizk), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1945 Azab (Dr. Ahmed Kamel), Département d'Entomologie, Faculté d'Agriculture, Université Fouad Ier, Sharia El-Madares, Ghizeh, près le Caire.

1950 Badawi (Aly Ibrahim), Démonstrateur au Département d'Entomologie, Faculté d'Agriculture, Université Ibrahim Pacha, Chebin El-Kom (Menoufieh), Basse-Egypte.

1938 Bailey Bros. and Swinfen Ltd., Minerva House, 26-27, Hatton Garden, Londres, E.C. 1, Angleterre.

1950 Baker (Captain D.B.), 21, Quarry Road Park, Cheam, Sutton, Surrey, Angleterre.

1929 Bichara (Ibrahim), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1946 Bigio (Henri), Embassy Court, 11, Sharia Gabalaya, Ghézireh, au Caire.

1929 Cassab (Antoine), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1950 Charkawi (Zaki Aly), Inspectorat du Ministère de l'Agriculture, Assouan (Haute-Egypte).

1931 Compagnie Universelle du Canal Maritime de Suez (Monsieur l'Agent Supérieur de la), 4-6, Sharia Lazoghli, Kasr El-Doubara, Boîte Postale N° 2120, au Caire.

1944 Coyne (Dr. F.P.), c/o Imperial Chemical Industries Ltd. (General Chemistry Division), Pest Control Section. Randle, Astmoor, Runcom, Cheshire, Angleterre.

1934 Crédit Foncier Egyptien (Monsieur l'Administrateur-Délégué), 35, Sharia Abd El-Khalek Saroit Pacha, au Caire.

1944 Daira Draneht Pacha, Boîte Postale N° 1277, Alexandrie.

1948 Daoud (Hanna), Section d'Entomologie, Ministère de l'Agriculture, Dokki, (Ghizeh), près le Caire.

1938 Directorate-General of Agriculture, Ministry of Economics. Baghdad, Irak.

1928 Dollfus (Robert Ph.), Directeur de Laboratoire et de Recherches, Museum National d'Histoire Naturelle, 57, Rue Cuvier, Paris (V^{me}), France.

1919 Efflatoun Bey (Prof. Hassan C.), Doyen et Professeur d'Entomologie, Faculté des Sciences, Université Fouad I^{er}, 16, Sharia Hoda Chaarawi, au Caire.

1951 Egyptoline, Société Egyptienne pour la lutte contre les maladies des plantes, 26, Sharia Sidi El-Mitwalli, Boîte Postale N° 1546, Alexandrie.

1946 El-Khishen (Dr. Shafik Aly), Faculté d'Agriculture, Université Farouk I^{er}, Chatby, Alexandrie.

1951 El-Mangoury (Mohamed Assaad), Laboratoire des Insectes Parasites, Cotton Research Board, Ghizeh (Orman), près le Caire.

1950 El-Naggar (Aly Abd El-Maksoud), Conseiller Technique de « The Near East Chemical and Fumigation C° (Amin Tewfik Bey and C°), 152, Sharia Tiba, Sporting (Ramleh), Alexandrie.

1948 El-Ziady (Mademoiselle Samira), M. Sc. Ent., Département d'Entomologie, Faculté des Sciences, Université Fouad I^{er}, Ghizeh (Orman), près le Caire.

1938 Esso Standard (Near East) Inc., 2, Midan Kasr El-Doubara, Boîte Postale N° 313, au Caire.

1947 Ezz (Ahmed Ibrahim), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1947 Ezzat (Yehia Mahmoud), 4314, 9th Street, N.W., Washington, D.C., Etats-Unis d'Amérique.

1944 Faculté d'Agriculture (Bibliothèque de la), Université Farouk I^{er}, Chatby, Alexandrie.

1934 Faculté d'Agriculture, Université Fouad I^{er}, Sharia El-Madares, Ghizeh, près le Caire.

1946 FACULTÉ DE MÉDECINE (Bibliothèque de la), Université Farouk Ier, Alexandrie.

1951 FARAG (Farag Anis), Département d'Entomologie, Faculté d'Agriculture, Université Ibrahim Pacha, Chebin El-Kom (Menoufieh), Basse-Egypte.

1951 FARBENFABRIKEN BAYER, (22c) Leverkusen-Bayerwerk, Zone Britannique, Allemagne.

1949 FLASCHENTRAEGER (Dr. Bonifaz), Professeur de Chimie Biologique, Faculté des Sciences, Université Farouk Ier, Moharrem Bey, Alexandrie.

1948 FRANGOPOULOS (Aristide Mikhali), Ingénieur Agronome, Borg Gianaclis, Abou Matamir (Béhéra), Basse-Egypte.

1950 FREY (Georg), 60, Osterwaldstrasse, Munich 23, Allemagne.

1950 GAD (Dr. Amin M.), Entomologiste, 8, Sharia El-Amir Tusun, Zamalek, au Caire.

1914 GARBOUA (Maurice), 1, Midan Soliman Pacha, au Caire.

1938 GHABN (Dr. Abd El-Aziz), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1927 GHALI Pacha (S.E. Wacef Boutros), 35, Sharia El-Ghizeh, Ghizeh, près le Caire.

1938 GHESQUIÈRE (J.), Ingénieur agronome, "Stella Mare", 9, Promenade du Maréchal Joffre, Menton (Alpes maritimes), France.

1921 GREISS (Elhamy), Professeur-adjoint de Botanique, Faculté des Sciences de l'Université Fouad Ier, 215, Sharia El-Malika, au Caire.

1942 HABIB (Abdallah), Conférencier en Entomologie à la Faculté d'Agriculture, Université Ibrahim Pacha, Chebin El-Kom (Menoufieh), Basse-Egypte.

1936 HAFEZ (Dr. Mahmoud), Professeur-Adjoint d'Entomologie, Faculté des Sciences, Université Fouad Ier, Ghizeh (Orman), près le Caire.

1944 HAFEZ (Moustafa), Laboratoire des Insectes Parasites, Cotton Research Board, Ghizeh (Orman), près le Caire.

1948 HAINES (Prof. R. Wheeler), Hôpital Demerdache, Sharia El-Malika (Abbassieh), au Caire.

1938 HAMZA (Soliman), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1944 HASSAN (Dr. Abbas Ibrahim), Département de Zoologie, Faculté des Sciences, Université Fouad Ier (Ghizeh, Orman), 80, Sharia Saleh El-Din, Héliopolis, près le Caire.

1945 HASSAN (Dr. Ahmed Abd El-Gawad), Section d'Entomologie, Faculté d'Agriculture, Université Farouk Ier, Chatby, Alexandrie.

1928 HASSAN (Dr. Ahmed Salem), Professeur de Zoologie Agricole et d'Entomologie à la Faculté d'Agriculture, Université Fouad Ier, Sharia El-Madares, Ghizeh, près le Caire.

1944 HASSAN (Mahrus Saleh), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1940 HIFNAOUI Pacha (S.E. le Prof. Mahmoud Tewfik), Conseiller Technique du Ministère de l'Agriculture et Président de la Société Fouad Ier d'Entomologie, Organisation des Nations Unies (F.A.O.), Immeuble Isis, 7, Sharia Lazoghli, Kasr El-Doubara, au Caire.

1949 HOARE (Geoffrey S.), c/o Turf Club, 19, Sharia Adly Pacha, au Caire.

1951 HOOGSTRAAL (Dr. Harry), Medical Zoologist and Explorer, United States Naval Medical Research Unit N° 3, Abbassieh, au Caire.

1927 HOUSNY (Mahmoud), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1950 HOUSNY (Salama Mohamed), Démonstrateur au Département d'Entomologie, Faculté d'Agriculture, Université Fouad Ier, Sharia El-Madares, Ghizeh, près le Caire.

1943 HUSSEIN (Mohamed), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1938 IBRAHIM (Abd El-Hamid Ibrahim), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Guizeh), près le Caire.

1940 IBRAHIM (Ahmed Housny), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1948 IBRAHIM (Mohamed Mahmoud), Laboratoire des Insectes Parasites, Cotton Research Board, Ghizeh (Orman), près le Caire.

1944 IMPERIAL CHEMICAL INDUSTRIES (EGYPT), S.A., 15, Midan Mohamed Aly, P.O. Bag, Alexandrie.

1936 IMPERIAL CHEMICAL INDUSTRIES (EGYPT), S.A., 26, Sharia Chérif Pacha, P.O.Bag, au Caire.

1950 ISSA (Gamal Ibrahim), Démonstrateur à la Faculté d'Agriculture, Université Ibrahim Pacha, Chebin El-Kom (Menoufieh), Basse-Egypte.

1928 IZZET Bey (Mohamed), 14, Midan El-Daher, au Caire.

1927 KAMAL Bey (Dr. Mohamed), Professeur d'Entomologie à la Faculté des Sciences, Université Farouk Ier (Moharrem Bey), 7, Sharia Saïd Pacha, Gianaclis, Ramleh, Alexandrie.

1922 KAOURK (Elias A.), Avocat, c/o Egyptian Markets Company Ltd, 14, Sharia Mohamed Farid Bey (ex Emad El-Dine), au Caire.

1943 KEFL (Ahmed Hassanein El-), Démonstrateur au Département d'Entomologie, Faculté d'Agriculture, Université Fouad Ier, Sharia El-Madares, Ghizeh, près le Caire.

1949 KEIMER (Dr. Louis), Professeur d'Egyptologie à la Faculté des Lettres, Université Fouad Ier, 17, Sharia Youssef El-Guindi, au Caire.

1950 KHALIFA (Dr. Abd El-Fattah), Conférencier à la Faculté d'Agriculture, Université Ibrahim Pacha, Chebin El-Kom (Menoufieh), Basse-Egypte.

1951 KNIGHT (Dr. Cdr. Kenneth L.), Officer in charge of Malaria and Mosquito Control Unit N° 1, United States Naval Air Station, Jacksonville, Florida, Etats-Unis d'Amérique.

1923 LABORATOIRES D'HYGIÈNE PUBLIQUE (Bibliothèque), Sharia El-Sultan Hussein, au Caire.

1931 LAND BANK OF EGYPT (Monsieur l'Administrateur-Directeur), Boîte Postale N° 614, Alexandrie.

1944 LEAN (Owen Bevan), Old Forge Cottage, Winkfield, Windsor, Angleterre.

1950 LE GROS (Armand Eugène), HQ. R.E. Stores Establishment, Melf. 15, Fanara.

1923 LIBRARIAN (The), Research Division Library, Ministry of Agriculture, Wad Medani, Soudan.

1931 LYCÉES FRANÇAIS (Monsieur le Proviseur), 2-4, Sharia Youssef El-Guindi, au Caire.

1932 MADWAR Bey (Dr. Saadallah Mohamed), Directeur Général du Département des Maladies Endémiques, Ministère de l'Hygiène Publique, Sharia El-Falaki, au Caire.

1948 MAHER ALY (Abd El-Meneim), University College London, London University, Londres, W.C. I, Angleterre.

1927 MANSOUR Bey (Prof. Dr. Kamel), D.Sc., Doyen de la Faculté des Sciences, Université Ibrahim Pacha, Ghireh (Orman), près le Caire.

1947 MEYMARIAN (Albert T.), Directorate of Agriculture, Baghdad, Iraq.

1921 MISTIKAWY (Abd El-Megid El-), Société Royale d'Agriculture, Boîte Postale N° 63, au Caire.

1945 MOAZZO (Polychronis Georges), 2, Sharia Young, Alexandrie.

1926 MOHAMED (Kassem), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1944 Morcos (Dr. Georges), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1929 Mosseri (Dr. Henri), 25, Sharia Talaat Harb Pacha, au Caire.

1944 Moursi (Dr. Abd El-Fattah Aly), Attaché Agricole, c/o Ambassade d'Egypte, Washington, Etats-Unis.

1943 Nakhla (Naguib), Assistant Technique, Section d'Entomologie. Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1950 Near East Chemical and Fumigation C° (The) (Amin Tewfik Bey and C°), 2, Sharia Toussoun Pacha, Boîte Postale N° 527, Alexandrie.

1951 Newbold Library (The), Gordon Memorial College, Boîte Postale N° 321, Khartoum, Soudan.

1942 Okbi (Mahmoud Ismail El-), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1951 Osman (Mohamed Fawzy Hassan), Département d'Entomologie, Faculté des Sciences, Université Fouad I^er^, Ghizeh (Orman), près le Caire.

1939 Pantos (Jean G.), Ingénieur Agronome, Boîte Postale N° 1074, Elisabethville, Congo Belge.

1944 Planta & C° (J.), Boîte Postale N° 450, Alexandrie.

1928 Priesner (Prof. Dr. H.), Professeur d'Entomologie à la Faculté des Sciences, Université Fouad I^er^, Ghizeh (Orman), près le Caire.

1951 Ramadan (Dr. Mahmoud M.), Département de Zoologie, Faculté des Sciences, Université Farouk I^er^, Moharrem Bey, Alexandrie.

1942 Rawhy (Soheil Hussein), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1943 Rizkallah (Ramses), Assistant Technique, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1925 Royal Entomological Society of London (The), 41, Queen's Gate, South Kensington, Londres, S.W. 7, Angleterre.

1948 Sabet Frères & Co. (Les Fils de D. Sabet), 9, Sharia Mohamed Farid Bey (ex Emad El-Dine), Boîte Postale N° 966, au Caire.

1951 Saenz (Dr. Abelardo), Colonia 1066, Montevideo, Uruguay (Amérique du Sud).

1943 Samak (Mohamed Mohamed), Assistant Technique, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1950 SAMHANE (Moustafa), Assistant Technique, Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1951 SAMUEL (Samir), Démonstrateur au Département de Parasitologie, Faculté de Médecine, Université Ibrahim Pacha, Sharia El-Malika, Abbassieh, au Caire.

1941 SAWAF (Saleh Kamel El-), Département d'Entomologie, Faculté d'Agriculture, Université Farouk Ier, Chatby, Alexandrie.

1936 SAYED (Dr. Mohamed Taher El-), Professeur d'Entomologie, Faculté des Sciences, Université Ibrahim Pacha, Ghizeh (Orman), près le Caire.

1951 SELIM (Mohamed Kamel), Démonstrateur à la Faculté de Médecine Vétérinaire, Université Fouad Ier, Ghizeh (Orman), près le Caire.

1938 SHAFIK Bey (Dr. Mohamed), Directeur Technique de la Société Financière et Industrielle d'Egypte, Boîte Postale N° 7, Kafr-Zayat, Basse-Egypte.

1950 SHALABY (Abd El-Salam), Démonstrateur au Département d'Entomologie, Faculté des Sciences, Université Farouk Ier, Moharrem Bey, Alexandrie.

1948 SHALABY (Fathy), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1921 SOCIÉTÉ ROYALE D'AGRICULTURE, Laboratoire d'Entomologie de la Section Technique, Boîte Postale N° 63, au Caire.

1951 SOLIMAN (Dr. A.A.), Département d'Entomologie, Faculté des Sciences, Université Farouk Ier, Moharrem Bey, Alexandrie.

1934 SOLIMAN Bey (Prof. Dr. Hamed Seleem), Vice-Recteur de l'Université Fouad Ier, Ghizeh (Orman), près le Caire.

1928 SOLIMAN (Dr. Labib Boutros), Directeur de la Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1950 STOWER (W.J.), Desert Locust Survey, c/o Department of Agriculture, B.A.E., Asmara, Erythrée.

1950 SULLAM AND Co. (Florio), 5, Sharia El-Hadiah, Kasr El-Doubara, Boîte Postale N° 793, au Caire.

1951 TAHA (Mahmoud Ismail), Département d'Entomologie, Faculté d'Agriculture, Université Farouk Ier, Chatby, Alexandrie.

1946 TAHER (Mahmoud), Section d'Entomologie, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

1926 Tewfik (Mohamed), Chef de Laboratoire et Conservateur des collections entomologiques de la Faculté des Sciences, Université Fouad Ier, Guizeh (Orman), près le Caire.

1950 Tolba (Mohamed Kamel Abd El-Megid), Conférencier en Entomologie, Faculté des Sciences, Université Ibrahim Pacha, Ghizeh (Orman), 75, Sharia Manial, au Caire.

1935 Tractor and Engineering Company, S.A.E. (The), 18, Sharia Mohamed Farid Bey (ex Emad El-Dine), Boîte Postale N° 366, au Caire.

1945 Triantaphyllidis (Nicolas P.), Assistant technique, Bureau de l'Attaché Agricole, Embassade d'Amérique, Athènes, Grèce.

1947 Waterston (A.R.), Entomologiste Conseil du B.M.E.O., 10, Sharia Tolumbat, Garden City, au Caire.

1947 Wiltshire (E.P.), c/o Consulat Britannique, Shiraz, Iran.

1946 Zaazou (Dr. Hussein), Département d'Entomologie, Faculté d'Agriculture, Université Farouk Ier, Chatby, Alexandrie.

1950 Zahar (A.R.), Chef du Service du Contrôle des Mouches, Section d'Eradication des Insectes, Ministère de l'Hygiène Publique, Sharia El-Falaki, au Caire.

1943 Zaki (Mikhaïl), Section d'Entomologie, Musée Agricole Fouad Ier, Dokki (Ghizeh), près le Caire.

1951 Zervudachi (Laky E.), Boîte Postale N° 1277, Alexandrie.

1938 Zoheiry Bey (Mohamed Soliman El-), Directeur-Général du Département de Protection des Plantes, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

Envois gracieux

Bibliothèque du Cabinet de Sa Majesté le Roi, Palais d'Abdine, au Caire.

Bibliothèque privée de Sa Majesté le Roi (Monsieur le Conservateur de la), Palais de Koubbeh, près le Caire.

Son Excellence le Ministre de l'Agriculture, Dokki (Ghizeh), près le Caire.

Son Excellence le Président du Conseil d'Administration de la Société Royale d'Agriculture, Boîte Postale N° 63, au Caire.

Monsieur l'Administrateur-Délégué du Crédit Foncier Egyptien, 35, Sharia Abdel Khalek Saroit Pacha, au Caire.

Son Excellence le Président du Conseil d'Administration de la Banque Misr, 151, Sharia Mohamed Farid Bey (ex Emad El-Dine), au Caire.

Monsieur le Directeur Général de l'Imperial Chemical Industries (Egypt), 26, Sharia Chérif Pacha, au Caire.

Monsieur le Directeur Général de la Société Financière et Industrielle d'Egypte, 2, Sharia Fouad I^{er}, Alexandrie.

Son Excellence le Sous-Secrétaire d'Etat, Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

Son Excellence le Secrétaire-Général du Ministère de l'Agriculture, Dokki (Ghizeh), près le Caire.

Son Excellence l'Administrateur Général de la Khassa Royale, Palais d'Abdine, au Caire.

Bibliothèque de l'Institut Fouad I^{er} du Désert, c/o Son Excellence l'Administrateur Général de la Khassa Royale, Palais d'Abdine, au Caire.

Bibliothèque Egyptienne, Midan Bab El-Khalq, au Caire.

Bibliothèque du Musée Agricole Fouad I^{er}, Dokki (Ghizeh), près le Caire.

Commission Internationale des Industries Agricoles, 18, Avenue de Villars, Paris (VII^{e}), France.

Unesco, Middle-East Science Cooperation Office, 8, Sharia Salamlik, Garden City, au Caire.

Conseil National des Recherches Fouad I^{er} (Bibliothèque du), 5, Sharia Sultan Hussein, au Caire.

Echanges

Afrique du Sud

South African Museum (The), P.O. Box 61, Cape Town.

Department of Agriculture of the Union of South Africa (The Agricultural Journal of the Union of South Africa). Pretoria.

Department of Agriculture of the Union of South Africa, Division of Entomology, P.O. Box 513, Pretoria.

The Director, The Transvaal Museum, P.O. Box 413, Pretoria.

Afrique Occidentale Française

Institut Français d'Afrique Noire, Boîte Postale N° 206, Dakar.

Afrique Orientale Portugaise

Memorias do Museu Dr. Alvaro de Castro, Caixa Postal 598, Lourenço Marques.

Algérie

Société d'Histoire Naturelle de l'Afrique du Nord, c/o Monsieur L. Faurel, Laboratoire de Botanique, Faculté des Sciences d'Alger, Alger.

Office National Anti-Acridien, Institut Agricole d'Algérie, Maison-Carrée, Alger.

Allemagne

Deutsche Entomologische Gesellschaft, 43, Invalidenstrasse, Berlin (IV).

Senckenbergische Naturforschende Gesellschaft (Bibliothek), Senckenberg-Anlage 25, Frankfurt am Main.

Bücherei des Zoologischen Museums, 43. Invalidenstrasse, Berlin N 4.

Gesellschaft für Vorratsschutz E.V. (Mitteilungen der), 31, Zimmermannstrasse, Berlin-Steglitz.

Bücherei der Biologischen Zentralanstalt für Land- und Forstwirtschaft, 19, Königin-Luise-Strasse, 1, Berlin-Dahlem.

Deutsches Entomologisches Institut (Arbeiten über morphologische und taxonomische Entomologie, Arbeiten über physiologische und angewandte Entomologie), 1, Waldowstrasse, Berlin-Friedrischhagen.

Museum für Natur-, Völker- und Handelskunde (Veröffentlichungen aus dem), Bahnhofsplatz, Brême.

Naturhistorische Verein der Rheinlande und Westfalens (Entomologische Blätter, Decheniana), 162, Koblenzerstrasse, Bonn.

Zoologische Sammlung des Bayerischen Staates, Münchner Entomologischen Gesellschaft E.V. (Mitteilungen der), 67, Menzingerstrasse, Zone Américaine, Munich 38.

Entomologische Arbeiten aus den Museum G. Frey, 60, Osterwaldstrasse, Munich 23, Allemagne.

Angleterre

The Commonwealth Institute of Entomology, Publication Office and Library (Review of Applied Entomology), 41, Queen's Gate, Londres, S.W. 7.

Zoological Museum (Novitates Zoologicæ), Tring Park, Tring, Herts.

Cambridge Philosophical Society, New Museums, Free School Lane, Cambridge.

The Director, Anti-Locust Research Centre, British Museum (Natural History), Londres, S.W. 7.

The Librarian, The Zoological Society of London, Regent's Park, Londres, N.W. 8.

The Librarian, Department of Entomology, University Museum, Oxford.

Argentine

Instituto Biologico de la Sociedad Rural Argentina, Buenos Aires.

Sociedad Cientifica Argentina, 11.45, Calle Santa Fé, Buenos Aires.

Sociedad Entomologica Argentina, 267, Calle Maipu, Buenos Aires.

Museo Argentino de Ciencias Naturales « Bernadino Rivadavia », e Instituto Nacional de Investigacion de las Ciencias Naturales, 470, Avenida Angel Gallardo, Buenos Aires.

Revista y Notas del Museo de la Plata (Zoologia), Facultad de Ciencias Naturales y Museo de la Plata (Biblioteca), La Plata.

Ministerio de Agricultura (Boletin del Ministerio de Agricultura de la Nacion), Bibliotheca, 974, Paseo Colon, Buenos Aires.

Fundacion Miguel Lillo, Universidad Nacional de Tucuman, Calle Miguel Lillo N° 205, Tucuman.

Asociacion Argentina de Artropodologia, Lacar 3722, Buenos Aires.

Australie

The Australian Museum (The Librarian), Sydney, N.S.W.

The Entomologist's Office, Department of Agriculture, Sydney, N.S.W.

The Public Library, Museum, and Art Gallery of South Australia (The South Australian Museum), Box 386 A, G.P.O., Adelaide, South Australia.

The Library, Divisions of Plant Industry and Entomology, P.O. Box N° 109, Canberra City, A.C.T.

The Linnean Society of New South Wales, Science House, Gloucester and Essex Streets, Sydney, N.S.W.

Waite Agricultural Research Institute, Private Mail Bag, Adelaide, South Australia.

Autriche

Administration-Kanzlei des Naturhistorischen Museums, Burgring 7 Vienne (I).

Zoologisch-Botanische Gesellschaft (Sekretariat), Burgring 7, Vienne (I).

Koleopterologische Rundschau, c/o Zoologisch-Botanische Gesellschaft. 2, Mechelgasse, Vienne (III).

Belgique

Société Entomologique de Belgique, Musée Royal d'Histoire Naturelle de Belgique, 31, Rue Vautier, Bruxelles, 4.

Société Scientifique de Bruxelles, Secrétariat, 11, Rue des Récollets, Louvain.

Bulletin de l'Institut Agronomique et des Stations de Recherches de Gembloux, Bibliothèque de l'Institut Agronomique de l'Etat, Gembloux.

Lambillionea, Revue Mensuelle Belge d'Entomologie, c/o M. Lucien Berger, 2, Vallée des Artistes, Linkebeek, Bruxelles.

Annales du Musée du Congo Belge, Tervuren.

Annales de Gembloux (Revue des Ingénieurs Agronomes de Gembloux), c/o Monsieur Réné Georlette, 207, Avenue Richard Neyberg, Bruxelles 2.

Brésil

Museu National, Quinta da Boa Vista, Rio de Janeiro.

Instituto Biologico, Bibliotheca, Caixa 119-A, São Paulo.

Instituto Oswaldo Cruz, Caixa de Correio 926, Rio de Janeiro.

Arquivos do Serviço Florestal, 1008, Jardim Botânico, Rio de Janeiro

Academia Brasileira de Ciencias (Anais da Academia Brasileira de Ciencias), Caixa Postal 229, Rio de Janeiro.

Faculdada Nacional de Filosofia, 40, Avenida Presidente Antonio Carlos, Rio de Janeiro.

« Dusenia », publicatio de scientia naturali, c/o Monsieur Ralph J.G. Hertel, Av. Vicente Machado, 1446, Curitiba, Parana.

Canada

Entomological Division, Science Service Building, Department of Agriculture, Ottawa, Ontario.

Bibliothèque du Ministère Fédéral de l'Agriculture, Edifice de la Confédération, Ottawa.

Entomological Society of Ontario (The Canadian Entomologist, and Reports), Guelph, Ontario.

Nova Scotian Institute of Science, Halifax.

Chine

The Lingnan Science Journal, Lingnan University, Canton.

Bulletin of the Biological Department, Science College, National Sun Yat-Sen University, Canton.

Bureau of Entomology of the Chekiang Province, West Lake, Hangchow.

Chypre

The Cyprus Agricultural Journal (The Office of the Government Entomologist), Nicosia.

Colombie (République de), Amérique du Sud

Facultad Nacional de Agronomia (Biblioteca de la), Medellin.

Cuba

Sociedad Cubana de Historia Natural « Felipe Poey » (Jefe de Redaccion de las Memorias de la), Museo Filipe Poey, Universidad de la Habana, La Havane, Cuba.

Danemark

Entomologisk Forening, Zoologisk Museum, Krystalgade, Copenhague.

Egypte

Ministère de l'Agriculture, Bibliothèque de la Section d'Entomologie, Dokki (Ghizeh), près le Caire.

Société Royale d'Agriculture, Bibliothèque de la Section Technique, Boîte Postale N° 63, au Caire.

Union des Agriculteurs d'Egypte, 25, Sharia Talaat Harb Pacha, au Caire.

Académie Egyptienne des Sciences (Monsieur le Secrétaire Honoraire de l'), Dar El-Hikma, 42, Sharia El-Kasr El-Aïni, au Caire.

Feuilles Agricoles, c/o Lycée Français, Chatby, Alexandrie.

Société Royale de Géographie d'Egypte, Bureau Postal de Kasr El-Doubara, au Caire.

Société Fouad Ier d'Economie Politique, de Statistique et de Législation, Boîte Postale N° 732, au Caire.

Institut d'Egypte, 13, Sharia El-Sultan Hussein, au Caire.

Bibliothèque de la Faculté des Sciences, Université Fouad Ier, Ghizeh (Orman), près le Caire.

The Royal Oceanographic Institute, Ghardaqua (Red Sea).

Equateur (République de l'), Amérique du Sud

Director General de Agricultura (Revista del Departamento de Agricultura), Quito.

Boletin de la Seccion Agricola del Banco Hipotecario del Ecuador, Apartado 685, Quito.

Espagne

Instituto Nacional de 2a Ensenanza de Valencia, Laboratorio de Hidrobiologia Espanola, Valencia.

Junta para ampliacion de Estudios e Investigaciones Cientificas, 4, Duque de Medinaceli, Madrid.

Eos, Revista Espanola de Entomologia, Instituto Espanol de Entomologia, Hipodromo, Madrid (VI).

Real Academia de Ciencias y Artes, 9, Rambla de los Estudios, Barcelona (II).

Real Sociedad Espanola de Historia Natural (Biblioteca), Palacio de Bellas Artes, 84, Avenida del Generalisimo, Madrid.

Estacion de Fitopatologia Agricola, 15, Miguel Angel, Madrid.

Instituto de Ciencias Naturales, Museo Municipal de Ciencias Naturales, Apartado de Correos 593, Barcelone.

Etats-Unis

The Research Library, Buffalo Society of Natural Sciences, Buffalo Museum of Science, Humboldt Park, Buffalo, New-York.

University of Illinois Library, Exchange Division, Urbana, Illinois.

The Library, American Museum of Natural History, Central Park West at 79th Street, New-York City.

Gifts and Exchanges Librarian-OJS, The Ohio State University (The Ohio Journal of Science), Colombus 10, Ohio.

California Academy of Science Library (Pan-Pacific Entomologist), Golden Gate Park, San Francisco, 18, California.

The Library Academy of Natural Sciences, Nineteenth and the Parkway, Philadelphia 3, Pennsylvania.

Experiment Station of the Hawaiian Sugar Planters' Association, P.O. Box 411, Honolulu, T.H., Hawaii.

Hawaiian Entomological Society (The Secretary), 1527, Keeaumoku Street, Honolulu 4, Hawaii.

Pacific Science, Department of Serials and Exchanges, University of Hawaii Library, Honolulu, Hawaii.

Carnegie Museum, Department of the Carnegie Institute, Pittsburgh, Pennsylvania.

American Entomological Society (The), 1900, Race Street, Logan Circle, Philadelphia 3, Pennsylvania.

United States National Museum, c/o Smithsonian Institution, Washington 25, D.C.

General Library, University of Michigan, Ann Arbor, Michigan

United States Department of Agriculture (The Library), Washington 25, D.C.

Smithsonian Institution Library, Washington 25, D.C.

New-York State College of Agriculture (The Library), Cornell University, Ithaca, New-York.

New-York Academy of Sciences, New-York.

General Library, Serials Department, University of California, Berkeley 4, California.

University of California, Citrus Experimental Station Library, Riverside, California.

University of California Library, Los Angeles 24, California.

Wisconsin Academy of Sciences, Arts, and Letters, Room 120, Wisconsin State Historical Building, Madison, Wisconsin.

The Library, Minnesota Agricultural Experiment Station, University Farm, Saint Paul, Minnesota.

Museum of Comparative Zoology, Harward College, Cambridge, Mass.

The Philippine Agriculturist (The Library of the College of Agriculture), Agricultural College, Laguna, Philippine Islands.

The Wasmann Collector (The Managing Director), Department of Biology, University of San Francisco, San Francisco 17, California.

The Reading Public Museum and Art Gallery (The Librarian), Reading PA.

Editorial Office, The American Midland Naturalist, University of Notre Dame, Notre Dame, Indiana.

Marine Biological Laboratory (The Library), Woods Hole, Mass.

State College of Washington Library, Technical Service Division, Serial Record Section, Pullman, Washington.

Finlande

Societas Entomologica Helsingforsiensis (Notulae Entomologicae), Museum Zoologicum, Helsinki.

Societas pro Fauna et Flora Fennica, Kaserngatan 24, Helsinki.

Societas Zoologica-Botanica Fennica Vanamo, Säätytalo, Snellmaninkatu 9-11, Helsinki.

Société Entomologique de Finlande (Annales Entomologici Fennici), Institut de Zoologie Agricole et Forestière de l'Université, Snellmaninkatu 5, III kerr., Helsinki.

France

Revue française d'Entomologie, Museum National d'Histoire Naturelle (Entomologie), 45 bis, Rue de Buffon, Paris (V^e).

Revue Scientifique du Bourbonnais et du Centre de la France, 22, Avenue Meunier, Moulins (Allier).

Société d'Etudes des Sciences Naturelles de Nîmes, 6, Quai de la Fontaine, Nîmes (Gard).

Société de Pathologie Végétale et d'Entomologie Agricole de France, Institut Pasteur, 25, Rue du Docteur Roux, Paris (XV^e).

Société Linnéenne de Bordeaux, Athénée, 53, Rue Des Trois Conils, Bordeaux.

Société Linnéenne de Lyon, 33, Rue Bossuet, Lyon (VI^e)

Société des Sciences Naturelles de l'Ouest de la France, 2, Rue Athénas, Nantes (Loire Inférieure).

Association des Naturalistes de Levallois-Perret, 153, Rue du Président Wilson (Domaine de la Planchette), Levallois-Perret (Seine).

Société Linnéenne du Nord de la France, 81, Rue Lemerchier (M. Pauchet), Amiens.

Société Géologique de Normandie et des Amis du Museum du Havre, Hôtel des Sociétés Savantes, 56, Rue Anatole France, Le Havre (Seine Inférieure).

Annales Scientifiques de Franche-Comté, 10, Rue de la Convention, Besançon (Doubs).

Société d'Histoire Naturelle de Toulouse (Monsieur P. Bonnet, Bibliothécaire de la), Faculté des Sciences, Toulouse.

Société Entomologique de France, Institut National Agronomique, 16, Rue Claude Bernard, Paris (V^e).

Société d'Etudes Scientifiques de l'Aude, Carcassone (Aude)

Annales des Epiphyties, Service de Documentation, Centre National de Recherches agronomiques, Route de Saint-Cyr, à Versailles (Seine et Oise).

Museum National d'Histoire Naturelle, Bibliothèque, 8, Rue de Buffon Paris (Ve).

Société de Zoologie Agricole (Revue de Zoologie Agricole et Appliquée), Faculté des Sciences, Institut de Zoologie, 40, Rue Lamartine, Talence (Gironde).

L'Entomologiste (Monsieur le Rédacteur en Chef de), Muséum National d'Histoire Naturelle, Entomologie, 45 bis, Rue de Buffon, Paris (Ve).

Rédaction du Bulletin Analytique, Service de Documentation du Centre National de la Recherche Scientifique, Ministère de l'Education Nationale, 45, Rue d'Ulm, Paris (Ve).

Institut des Fruits et Agrumes Coloniaux (Fruits d'Outre Mer), 6, Rue du Général Clergerie, Paris (XVIe).

Grèce

Institut Phytopathologique Benaki, Kiphissia (près Athènes).

Bibliothèque de l'Institut et Musée Zoologique de l'Université, Athènes.

Hollande

Nederlandsche Entomologische Vereeniging (Bibliotheek van der), Zeeburgerdijk. 21, Amsterdam (O).

Landbouwhoogeschool, Laboratorium voor Entomologie, Berg 37, Wageningen.

Hongrie

Természettudomanyi Muzeum, 13, Baross-utca, Budapest.

Indes

The Director, Zoological Survey of India (Records and Memoirs of the Indian Museum), 27, Chowringhee, Calcutta 13.

Madras Government Museum, Connemara Public Library, Egmore, Madras 8.

Office of the Director, Agricultural Research Institute, New Delhi.

The Honorary Secretary, Zoological Society of Bengal (Proceedings of the), 35, Ballygunge Circular Road, Calcutta 19.

Indonésie

Bibliotheca Bogoriensis, Centrale Natuurwetenschappelijke Bibliotheek, 20, Djalan Raya, Bogor, Java.

Iran

Laboratoires du Département Général des Recherches Agronomiques (Monsieur le Directeur), Ministère de l'Agriculture, Tehran.

Italie

Museo Civico di Storia Naturale « Giacomo Doria », 9, Via Brigata Liguria, Genova (102).

Museo Civico di Storia Naturale di Trieste (Atti del), 4, Piazza Hortis, Trieste (10).

Società dei Naturalisti in Napoli, Università di Napoli, Via Mezzocannone, Napoli.

Società Entomologica Italiana, Museo Civico di Storia Naturale, 9, Via Brigata Liguria, Genova (102).

Società Adriatica di Scienze Naturali (Bibliotecario della), 7, Via dell' Annunziata, Trieste 110.

La Stazione di Entomologia Agraria (Redia), 15-17, Via Romana, Firenze.

La Stazione Sperimentale di Gelsicoltura e Bachicoltura di Ascoli Piceno.

Istituto Zoologico dell'Università di Napoli (Biblioteca del), Via Mezzocannone, Napoli.

Laboratorio di Zoologia Generale e Agraria della Facolta Agraria, Portici (Napoli).

Ra. Laboratorio di Entomologia Agraria di Portici (Bolletino del), Portici (Napoli).

Institut International d'Agriculture (Bibliothèque de l'), Villa Umberto I, Rome.

Società Italiana di Scienze Naturali, Palazzo del Museo Civico di Storia Naturale, Corso Venezia, Milano.

Istituto di Zoologia dell'Università di Genova (Bolletino dei Musei di Zoclogia e di Anatomia comparata), 5, Via Balbi, Genova.

Società dei Naturalisti e Matematici di Modena, presso l'Università, Modena.

Istituto di Entomologia dell'Università, 6, Via Filippo Re, Bologna (125).

Accademia di Scienze, Lettere ed Arti in Padova, 15, Via Accademia, Padova (Veneto).

Museo di Storia Naturale della Venezia Tridentina (« Memorie del Museo di Storia Naturale della Venezia Tridentina » e « Studi Trentini di Scienze Naturali »), Casella Postale 95, Trento.

Istituto Agronomico per l'Africa (Rivista di Agricoltura subtropicale e tropicale), Ministero dell'Africa, 13, Via Fibonacci, Firenze.

Istituto di Entomologia Agraria della Ra. Università (Bolletino di Zoologia Agraria e Bachicoltura), 2, Via Celoria, Milano.

Società Veneziana di Storia Naturale (presso Sig. Antonio Giordàni Soika), S. Marco 254, Venezia.

Museo Civico di Storia Naturale, 9, Lungadige Porta Vittoria, Verona.

Japon

The Ohara Institute for Agricultural Research, Library, Kurashiki, Okayama-Ken.

Imperial Agricultural Experiment Station (Journal of the), Nishigahara. Tokyo.

Department of Agriculture, Government Research Institute, Taihoku Formosa.

The Kansai Entomological Society, c/o N. Tosawa, Shibakawa-Noen. Kotoen, Mukogun, Hyogo-ken.

« Mushi », Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka.

Takeuchi Entomological Laboratory (Tenthredo, Acta Entomologica). Shinomyia Yamashina, Kyoto.

Kenya Colony (British East Africa).

East Africa Natural History Society (The Hon. Secretary), Coryndon Memorial Museum, P.O. Box 658, Nairobi.

Maroc

Société des Sciences Naturelles du Maroc, Institut Scientifique Chérifien, Avenue Biarnay, Rabat.

Service de la Défense des Végétaux (Monsieur le Chef du), 65 bis, Avenue de Témara, Rabat.

Mexique

Biblioteca del Instituto de Biologia, Chapultepec (Casa del Lago), Mexico, D.F.

Anales de la Escuela Nacional de Ciencias Biologicas, Apartado Postal 7016, Mexico, D.F.

Norvège

Tromso Museum Library, Tromso.

Panama (République de)

Departamento Seccional de Agricultura (Boletin Agricola), Panama.

Pologne

Musée Zoologique Polonais, ul. Wilcza N° 64, Varsovie.

Bulletin Entomologique de la Pologne, Sienkiewicza 21, Wroclaw.

Institut des Recherches Forestières (Bibliothèque), 52-54, Rue Wawelska, Varsovie (22).

Uniwersytet Marii Curie-Sklodowskiej, Biuro Wydawnictw, 5, Plac Litewski, Lublin.

Acta Musei Historiae Naturalis, Musée d'Histoire Naturelle, 17, Slawkowska, Cracovie.

Académie Polonaise des Sciences et des Lettres, 17, Rue Slawkowska, Cracovie.

Portugal

Société Portugaise des Sciences Naturelles (Bibliothèque de la), Institut de Botanique, Faculté des Sciences, Lisbonne.

Museum Zoologique de l'Université de Coimbra, Largo Marquês de Pombal, Coimbra.

Associaçao da Filosofia Natural (Bibliotecario da), Faculdade de Ciencias, Porto.

Instituto de Medicina Tropical (Monsieur le Directeur de l'), Lisbonne.

Conselho de Administraçao da Companhia de Diamantes de Angola, Lisbonne.

Roumanie

Société Transylvanienne des Sciences Naturelles (Siebenbürgischer Verein für Naturwissenschaften), Hermannstadt, Sibiu.

Academia Romana, Bibliothèque, Calea Victoriei, 125, Bucarest.

Russie (U.R.S.S.)

Société Entomologique de Russie (Revue d'Entomologie de l'U.R.S.S.), Musée Zoologique de l'Académie des Sciences, Léningrad.

Bibliothèque de l'Académie des Sciences de l'Ukraine, 58a, Rue Korolenko, Kiew (Ukraine).

Institut des Sciences Naturelles, Université M. Gorky, 1 ul. Genkelya, Zaimka, Molotov (Ourals).

The Lenin Academy of Agricultural Sciences, Institute for Plant Protection, 42, Herzen str., Leningrad.

Rédaction du Journal « Plant Protection », 7, Rue Tschaikovsky, Léningrad.

Institute for controlling Pests and Diseases, Library, 7, Rue Tschaikovsky, Léningrad 28.

Suède

K. Swenska Vetenskapsakademien i Stockholm (Bibliotek), Stockholm 50.

Bibliothèque de la Section Entomologique du Museum National d'Histoire Naturelle (Entomologisk Tidskrift), Stockholm 50.

Göteborgs Kungl. Vetenskaps-och Vitterhets Samhälles, Göteborg.

Statens Växtskyddsanstalt, Stockholm 19.

Bibliothèque de l'Université de Lund, Lund.

Suisse

Bibliothèque de la Société Entomologique Suisse, Musée d'Histoire Naturelle, Berne.

Tauschverkehr der Naturforschenden Gesellschaft, Zentralbibliothek, Zähringerstrasse 6, Zurich I.

Tchécoslovaquie

Societas Entomologica Cechosloveniae (Casopis), Vinicna 7, Zoolog-Ustav-Csr., Prague II.

Museum National de Prague, Section de Zoologie (Sbornik Entomologického Oddeleni et Sbornik Narodniho Musea v Praze), Prague II, 1700.

Bibliothèque de la Société Zoologique Tchécoslovaque, Institut de Zoologie, Vinicna 7, Prague II.

Institut d'Entomologie Appliquée (Folia Entomologica), 1, Zemedelska, Brno.

Tunisie

Bulletin de la Société des Sciences Naturelles de Tunisie, 2, Rue de Souk-Ahras, Tunis.

Uruguay (République de l')

Escuela de Veterinaria del Uruguay (Anales de la Escuela de Veterinaria del Uruguay), Itazaingo 1461, Montévideo.

Sociedad de Biologia de Montevideo, Casilla de Correo 567, Montevideo.

Abonnements de la Société

Bulletin of Entomological Research, The Commonwealth Institute of Entomology, 41, Queen's Gate, S.W. 7, Londres, Angleterre.

Zoological Record (Insecta), The Commonwealth Institute of Entomology, 41, Queen's Gate, South Kensington, S.W.7, Londres, Angleterre.

Proceedings and Transactions of the Royal Entomological Society of London, 41, Queen's Gate, South Kensington, Londres, S.W.7, Angleterre,

Journal of the Entomological Society of Southern Africa, The Honorary Secretary, P.O. Box 103, Prétoria, Afrique du Sud.

The Annals of Applied Biology, Cambridge University Press, Cambridge, Angleterre.

Parasitology, Cambridge University Press, Cambridge, Angleterre.

Transactions and Journals of the Society for British Entomology, c/o Dr. S C.S. Brown, 454, Christchurch Road, Bournemouth, Hants, Angleterre.

PROCÈS-VERBAUX DES RÉUNIONS

Réunion du Conseil du 21 Février 1951

Présidence de Monsieur le Professeur H.C. EFFLATOUN Bey, *Vice-Président.*

Nécrologie :

La Société a le vif regret de faire connaître le décès de notre membre correspondant Arturo Schatzmayr, de Trieste. Schatzmayr a visité l'Egypte en 1934. Ses récoltes entomologiques dans ce Pays, en particulier les Coléoptères, ont fait l'objet d'une série de travaux qu'il a publiés dans notre Bulletin et dans diverses Revues italiennes. Avec la disparition de ce distingué collègue, l'entomologie perd un de ses plus fervents adeptes et zélés animateurs.

Distinctions honorifiques :

Nous avons le grand plaisir de faire savoir que notre Vice-Président, Monsieur H.C. Efflatoun Bey, a été nommé Bey de première classe et lauréat du Prix Farouk I (1951) pour les sciences; Monsieur le Professeur Docteur Hamed Seleem Soliman Bey a été nommé Bey de première classe; Messieurs le Docteur Mohamed Kamal Bey et Anastase Alfieri ont été nommés membres de l'Institut Fouad I du Désert (Section Zoologique); enfin, Messieurs le Docteur Abbas Ibrahim Hassan et Mohamed Tewfik ont été nommés membres du Comité de Zoologie de l'Institut Fouad I du Désert.

Toutes nos félicitations à ces distingués collègues.

Subvention et Donation :

La Société a reçu livres égyptiennes 997 et 600 millièmes à titre de subvention du Ministère de l'Agriculture pour l'année 1950. L'Imperial Chemical Industries nous a fait parvenir sa donation de livres égyptiennes 10.

Le Conseil remercie.

Don à la Bibliothèque :

Monsieur J. Ghesquière, de Bruxelles, adresse seize separata de ses travaux entomologiques publiés durant les années 1949-1950.

Le Conseil remercie.

Nomination de Membres :

Sont admis à faire partie de la Société : Monsieur Mohamed Assaad El-Mangouri, assistant-entomologiste au Laboratoire des Parasites du Ministère de l'Agriculture, présenté par Messieurs Fathy Shalaby et A. Alfieri; Monsieur Mahmoud Ismail Taha, du Département d'Entomologie de la Faculté d'Agriculture (Université Farouk I), présenté par Messieurs le Docteur Abd El-Fattah Khalifa et A. Alfieri; Monsieur le Docteur M.M. Ramadan, professeur-adjoint de Zoologie à la Faculté des Sciences (Université Farouk I), présenté par Messieurs le Professeur H.C. Efflatoun Bey et A. Alfieri; Monsieur Farag Anis Farag, démonstrateur au Département d'Entomologie de la Faculté d'Agriculture (Université Ibrahim Pacha), présenté par Messieurs le Docteur Abd El-Fattah Khalifa et Abdallah Habib; Monsieur le Docteur A.A. Soliman, conférencier au Département d'Entomologie de la Faculté des Sciences (Université Farouk I), présenté par Monsieur le Docteur Mohamed Kamal Bey et A. Alfieri; la Newbold Library du Gordon Memorial College de Khartoum (Soudan), présentée par Messieurs le Professeur H.C. Efflatoun Bey et A. Alfieri.

Echange de Publications :

L'échange mutuel des publications est établi avec (1) la Bibliothèque de l'Université de Californie (Los Angeles) et (2) la Revue Internationale des Industries Agricoles (Paris).

Abonnement :

Le Conseil décide l'abonnement de la Société aux « Transactions and Journals of the Society for British Entomology » de Bournemouth (Angleterre).

Rapports annuels :

Le Conseil approuve les Rapports du Secrétaire Général, du Trésorier et des Censeurs pour l'Assemblée Générale Ordinaire qui est fixée au 21 Mars 1951.

Assemblée Générale Ordinaire du 21 Mars 1951

Présidence
de Monsieur le Professeur H. C. EFFLATOUN Bey, *Vice-Président.*

Rapport du Secrétaire Général (Exercice 1950) :

Messieurs,

Aux termes des Articles 24, 25 et 26 de nos Statuts, nous vous avons convoqués en Assemblée Générale Ordinaire pour vous communiquer les Rapports du Secrétaire Général, du Trésorier et des Censeurs sur la situation morale, financière et comptable de la Société, pour donner au Conseil décharge de sa gestion, et pour procéder, par voie d'élections, au remplacement des Membres sortants du Conseil, et des deux Censeurs des comptes de l'Exercice en cours.

Vous aurez également, conformément à l'Article 13 des Statuts, à ratifier la nomination de Monsieur le Docteur Saadallah Mohamed Madwar Bey comme membre du Conseil, en remplacement de notre collègue Edgard Chakour qui a dû s'absenter d'Egypte pour une longue période.

Messieurs,

C'est avec un profond regret que nous avons appris le décès de Charles Alluaud, membre honoraire, et d'Emmanuel Zervudachi, membre titulaire. Aux Institutions scientifiques auxquelles ils appartenaient, et à leurs familles nous présentons l'expression de nos condoléances les plus émues. Nous vous prions, Messieurs, de respecter une minute de silence en leur mémoire.

Messieurs,

Durant l'Exercice écoulé, l'Institut Fouad Ier du Désert a fait appel à notre collaboration en vue de l'organisation de sa section zoologique et particulièrement de son Musée entomologique. Cette tâche a été menée à bonne fin malgré le temps très limité dont nous disposions.

D'autre part, votre Conseil a approuvé le transfert à cet Institut, à titre de dons, des ouvrages et des collections zoologiques et botaniques ci-après :

(1) Une série complète de nos Bulletins et de nos Mémoires (1908-1949).

(2) L'herbier Pfund, comprenant près de 3000 spécimens récoltés au Kordofan et au Darfour durant les années 1875-1876.

(3) Le Rapport du Docteur J. H. Zarb, relatif à l'herbier précité, imprimé au Caire en 1879.

(4) Un herbier contenant un millier de spécimens des récoltes faites en Egypte par E. Sickenberger (1879-1880) et par Ernst Hartmann (1909-1911).

(5) Une collection de Lichens d'Egypte (55 espèces représentées par plus de 300 exemplaires) récoltés par E. Sickenberger.

(6) 21 spécimens ornithologiques, naturalisés, de la faune désertique.

(7) 215 œufs d'oiseaux contenus dans 71 boîtes vitrées.

Messieurs,

Comme par le passé, nous nous sommes tenus à l'entière disposition des techniciens du Ministère de l'Agriculture, du corps enseignant et des étudiants des Facultés des Sciences, d'Agriculture et de Médecine des Universités Fouad I[er], Farouk I[er] et Ibrahim Pacha El-Kébir, des diverses institutions scientifiques, des groupements scolaires, et de toutes les personnes venues consulter notre bibliothèque, travailler dans nos laboratoires, ou visiter notre musée. Nous leur avons fourni d'amples références scientifiques, ainsi qu'un très grand nombre de déterminations d'insectes.

Dix-huit conférences ont été faites dans notre Siège.

Nous avons adhéré au IX[e] Congrès International d'Entomologie qui se tiendra à Amsterdam du 17 au 24 Août 1951.

Le trente-quatrième volume de notre Bulletin, composé de 364 pages abondamment illustrées, vous a été distribué récemment. Il contient quatorze études originales dûes à l'activité de nos membres.

Votre Conseil a procédé à la nomination de neuf membres honoraires et de huit membres correspondants nouveaux, choisis parmi les plus grandes sommités entomologiques.

D'autre part, nous enregistrons dix-huit nouvelles adhésions de membres titulaires, contre sept démissions.

Au titre des donations figurent celles de la Société Royale d'Agriculture, du Crédit Foncier Egyptien, de la Banque Misr et de la Société Financière et Industrielle d'Egypte, de L.Eg. 50, 50, 20 et 15 respectivement. Nous réitérons nos remerciements et notre profonde gratitude à l'adresse de ces grandes Institutions égyptiennes.

Citons également deux dons très importants faits à la Bibliothèque par la Société Entomologique de Belgique (volumes I-XXII de ses Mémoires) et par Monsieur Edgard Chakour (Charles d'Orbigny : Dictionnaire Universel d'Histoire Naturelle, 17 volumes dont 3 Atlas, reliés). Que ces généreux donateurs trouvent ici, avec nos remerciements, l'expression de toute notre gratitude.

Dans notre Bibliothèque figurent actuellement 17579 ouvrages et brochures, dûment enregistrés, contre 17117 l'année précédente, soit en augmentation de 462 unités, dont 76 représentent les dons reçus, 44 proviennent

de nos achats (L.Eg. 68.495) et abonnements (L.Eg. 15.865), le restant obtenu par l'échange de nos publications avec près de 230 Institutions entomologiques ou scientifiques de tous pays. D'autre part, nous avons consacré L.Eg. 51.100 pour la reliure de 146 volumes.

Votre Trésorier a établi le Bilan des Comptes de l'Exercice, dûment vérifié et approuvé par vos Censeurs, ainsi que les Prévisions Budgétaires pour l'Exercice 1951.

Au 31 Décembre, date de clôture de nos comptes, nous n'avions pas encore reçu la subvention annuelle du Ministère de l'Agriculture. Nos prévisions budgétaires en ont été troublées et le déficit de L.Eg. 1364.836 qui en est résulté a dû être comblé par un nouveau prélèvement opéré sur le capital social.

Le coût de la vie continue sa courbe ascendente, les frais d'impression, de clichage et autres, sont élevés. D'autre part, la précarité de nos ressources nous oblige, depuis bientôt quinze ans, de différer les nombreux travaux de réparation et de rafraîchissement indispensables à la bonne conservation de notre Siège. Comme vous le voyez, les perspectives ne sont guère encourageantes.

Aux termes de l'Article 13 de nos Statuts, le Conseil est annuellement renouvelé par tiers. Les membres sortants, cette année, sont les suivants : Messieurs Mohamed Soliman El-Zoheiry Bey, le Professeur Docteur Hamed Seleem Soliman Bey, et le Docteur Mohamed Shafik Bey. Ils sont rééligibles.

Vos Censeurs, Messieurs E.A. Kaourk et Elhamy Greiss, sont également rééligibles.

En terminant, nous prions le Tout-Puissant d'entourer de Sa divine Protection notre Auguste Souverain Bien-Aimé, Sa Majesté le Roi Farouk I^{er}, pour le plus grand bien de notre cher Pays.

Signé: A. ALFIERI.

Rapport du Trésorier :

Situation au 31 Décembre 1950

DÉPENSES	L.E.	MM.	RECETTES	L.E.	MM.
Loyer	1	005	Subvention Ministère Agriculture	—	—
Impôts et Assurances	84	416	Donations	135	000
Frais Généraux et Entretien	307	567	Cotisations des Membres	119	830
Personnel	1314	500	Droits d'Inscription	3	600
Publications	441	944	Intérêts de Banque	12	546
Bibliothèque	135	460	Coupons Emprunt National	583	520
Collections	11	600	Vente Publications	60	160
			Encaissements divers	17	000
			Déficit prélevé sur la Réserve Générale	1364	386
	2296	492		2296	492

ACTIF	L.E.	MM.	PASSIF	L.E.	MM.
Immeuble Social	1	000	Réserve Générale	13863	467
Mobilier	1	000			
Bibliothèque	1	000			
Collections	1	000			
Laboratoires	1	000			
Banque Nationale d'Egypte	666	208			
Portefeuille Emprunt National	13187	630			
Compagnie du Gaz	4	629			
	13863	467		13863	467

Portefeuille Titres en dépôt à la Banque Nationale d'Egypte : 18000 L.Eg. Emprunt National 3 1/4 % (1963-1973).

Signé : R. WILKINSON.

Rapport des Censeurs :

En exécution du mandat que vous avez bien voulu nous confier, nous avons l'honneur de porter à votre connaissance que nous avons vérifié les Comptes de la Société Fouad Ier d'Entomologie pour l'année finissant le 31 Décembre 1950, avec les régistres et documents y relatifs.

Nous certifions que le Bilan reflète d'une façon exacte et sincère la situation de la Société telle qu'elle ressort des régistres et des explications qui nous ont été données.

Signé : E. A. Kaourk et Elhamy Greiss.

Prévisions Budgétaires pour l'année 1951 :

RECETTES	L.E.	MM.	DÉPENSES	L.E.	MM.
Subvention Ministère Agriculture	1000	000	Loyer	1	000
Donations	135	000	Impôts	57	000
Cotisations des Membres	120	000	Assurances	27	000
Coupons Emprunt National	583	000	Frais Généraux	270	000
Intérêts de Banque	12	000	Entretien	40	000
Vente Publications	5	000	Personnel	1315	000
Prélèvement sur la Réserve Générale	545	000	Publications	550	000
			Bibliothèque	100	000
			Imprévus	40	000
	2400	000		2400	000

Signé : Wilkinson.

Décisions :

(1) Le Procès-Verbal de l'Assemblée Générale Ordinaire du 8 Mars 1950 est lu et confirmé.

(2) La nomination de Monsieur le Docteur Saadallah Mohamed Madwar Bey comme membre du Conseil, en remplacement de Monsieur Edgard Chakour, est ratifiée.

(3) Les Rapports du Secrétaire Général, du Trésorier et des Censeurs pour l'Exercice 1950, ainsi que les Prévisions Budgétaires pour l'Exercice 1951, sont adoptés.

(4) L'Assemblée donne décharge au Conseil de sa gestion pour l'Exercice 1950, et émet le vœu que des démarches soient entreprises en vue de l'augmentation du montant de la subvention annuelle du Ministère de l'Agriculture, et aussi pour trouver de nouvelles ressources indispensables à la bonne marche de la Société.

Elections :

Messieurs le Professeur Docteur Hamed Seleem Soliman Bey, Mohamed Soliman El-Zoheiry Bey, et le Docteur Mohamed Shafik Bey, membres du Conseil sortants, sont réélus. Leur mandat a une durée de trois ans.

Messieurs E.A. Kaourk et Elhamy Greiss sont réélus Censeurs des Comptes de la Société pour l'Exercice 1951.

Félicitations et Remerciements :

Sur la proposition du Président, l'Assemblée Générale Ordinaire félicite les Membres du Conseil et les Censeurs réélus. Elle vote une motion de remerciements à l'adresse de Messieurs le Secrétaire Général, le Trésorier, les Membres du Conseil, les Censeurs, et de tous ceux qui, par leurs dons, leur collaboration et leur sympathie constante, ont aidé la Société à accomplir sa tâche durant de l'Exercice 1950.

Réunion du Conseil du 18 Avril 1951

Présidence de Monsieur le Professeur H. C. EFFLATOUN Bey, *Vice-Président.*

Donation :

Le Crédit Foncier Egyptien a fait parvenir L.E. 51 à titre de donation pour l'année 1951.

Le Conseil remercie.

Don à la Bibliothèque :

Monsieur A.S. Balachowsky, de l'Institut Pasteur de Paris, a fait parvenir un exemplaire de son ouvrage « La lutte contre les Insectes », récemment édité.

Monsieur le Docteur Marcello La Greca, de Naples, nous a adressé trois separata de ses travaux sur les Orthoptères, publiés durant les années 1949 et 1950.

Le Conseil remercie.

Nomination de Membres :

Sont admis à faire partie de la Société : Monsieur le Docteur Abelardo Saenz (Hijo), de Montévideo (Uruguay), présenté par Messieurs le Professeur Docteur H. Priesner et A. Alfieri; Monsieur Anwar Mohamed Abou El-Ezz, de la Section d'Entomologie du Ministère de l'Agriculture, présenté par Messieurs Mahmoud Housny et Antoine Cassab; Monsieur Mohamed Fawzy Hassan Osman, du Département d'Entomologie de la Faculté des Sciences (Université Fouad I), présenté par Messieurs le Professeur H.C. Efflatoun Bey et le

Docteur Mahmoud Hafez; Monsieur Omar Abd El-Aziz, présenté par Messieurs le Professeur Docteur Hamed Seleem Soliman Bey et le Docteur Ahmed Salem Hassan; Egyptoline (Société Egyptienne pour la lutte contre les maladies des plantes), présentée par Messieurs Mohamed Tewfik et A. Alfieri.

Bureau du Conseil pour l'Exercice 1951 :

Sont réélus : Messieurs le Professeur H.C. Efflatoun Bey et Mohamed Soliman El-Zoheiry Bey, *Vice-Présidents;* Monsieur A. Alfieri, *Secrétaire Général;* Monsieur Richard Wilkinson, *Trésorier.*

Comité Scientifique :

Sont réélus : Messieurs le Professeur H.C. Efflatoun Bey, Professeur Docteur Hamed Seleem Soliman Bey, Professeur Docteur Kamel Mansour Bey, Mohamed Soliman El-Zoheiry Bey, Professeur Docteur H. Priesner, Docteur Mahmoud Hafez, et A. Alfieri.

Commémoration du Quinzième Anniversaire de la mort du Roi Fouad Ier (28 Avril 1951)

Le Conseil de la Société a été présent, à la Mosquée Rifaï, à l'occasion de la Commémoration du Quinzième Anniversaire de la mort du Très-regretté Roi Fouad Ier. Il a déposé une couronne dans le mausolée royal, et, à l'issu de la cérémonie, s'est inscrit sur les régistres du Palais d'Abdine.

Anniversaire de l'Avènement au Trône de Sa Majesté le Roi Farouk Ier (6 Mai 1951)

A l'occasion de l'Avènement au Trône de Sa Majesté le Roi Farouk Ier, le Conseil d'Administration et les Membres de la Société ont adressé une dépêche à Son Excellence le Grand Chambellan, le priant de transmettre à l'Auguste Souverain leurs félicitations et leurs vœux les plus sincères.

Séance Publique du 16 Mai 1951

Présidence de Monsieur le Professeur H.C. Efflatoun Bey, *Vice-Président.*

Communications :

Tous les travaux scientifiques présentés à cette réunion seront publiés dans nos Bulletins.

Réunion du Conseil du 30 Mai 1951

Présidence de Monsieur le Professeur H.C. Efflatoun Bey,
Vice-Président

Distinctions honorifiques :

Le Président adresse les félicitations de la Société à nos distingués collègues : Monsieur le Professeur Docteur Hamed Seleem Soliman Bey, qui vient d'être nommé Vice-Recteur de l'Université Fouad I, et Monsieur le Professeur Docteur Kamel Mansour Bey pour le titre de Bey qui lui a été récemment conféré.

IXe Congrès International d'Entomologie :

Notre Vice-Président, Monsieur le Professeur H.C. Efflatoun Bey, a représenté la Société à ce Congrès qui s'est tenu à Amsterdam du 17 au 24 Août 1951.

Nomination de Membres :

Sont admis à faire partie de la Société : Monsieur le Docteur Harry Hoogstraal, de l'U.S. Naval Medical Research Unit Nr 3, présenté par Messieurs le Docteur Albert A. Abdel Malek et A. Alfieri, et Monsieur le Docteur Kenneth L. Knight, présenté par Messieurs le Professeur H.C. Efflatoun Bey et le Docteur Albert A. Abdel-Malek.

Réunion du Conseil du 24 Octobre 1951

Présidence de Monsieur le Professeur H.C. Efflatoun Bey,
Vice-Président

Nécrologie :

Le Président a le regret de faire part du décès de deux de nos collègues : Alexandre Carneri, membre de la Société depuis 1928, décédé à Alexandrie le 6 Juillet 1951, et Richard Wilkinson, membre du Conseil et Trésorier de la Société depuis 1912, décédé à Alexandrie le 6 Septembre 1951.

Richard Wilkinson qui en 1912 occupait depuis longtemps déjà les fonctions de Chef Caissier de la Banque Nationale d'Egypte, avait été sollicité par l'un des fondateurs de la Société avec lequel il était apparenté, feu le Docteur Walter Innes Bey, de se charger de la Trésorerie de notre Société. Wilkinson, qui n'était pas entomologiste, s'y prêta de grand cœur et assuma ces fonctions jusqu'à sa mort. Il fut parmi nous l'exemple de tous les dévouements, et c'est avec d'unanimes regrets que tous ses collègues attristés ont appris sa disparition.

Une minute de silence est observée en leur mémoire.

Echange de Publications :

Le Conseil approuve l'échange des publications de la Société contre : (1) Pacific Science, édité par l'Université de Hawaii (Honolulu) ; (2) l'Entomologische Arbeiten aus dem Museum G. Frey, Munich ; (3) Memorias do Museu Dr. Alvaro de Castro, Lourenço Marques, Afrique Orientale Portugaise.

Nomination de Membres :

Sont admis à faire partie de la Société : la Farbenfabricken Bayer, d'Allemagne, présenté par Messieurs le Professeur Docteur H. Priesner et A. Alfieri; Monsieur Mohamed Kamel Selim, démonstrateur à la Faculté de Médecine Vétérinaire (Université Fouad Ier), et Monsieur Samir Samuel, démonstrateur au Département de Parasitologie de la Faculté des Sciences (Université Fouad Ier), présentés par Messieurs le Docteur Mahmoud Hafez et A. Alfieri.

Don à la Bibliothèque :

La Société a reçu : (1) de Monsieur Adel Abou Nasser, un exemplaire de ses douze travaux sur l'entomologie appliquée du Liban ; (2) de Monsieur R.E. Snodgrass, son ouvrage « Comparative studies on the head of mandibulate arthropods » ; (3) de Monsieur le Docteur Fabio Invrea, de Gênes, cinq separata de ses travaux sur les Chrysidides et sur les Mutillides paléarctiques ; (4) de notre collègue E.P. Wiltshire, un tiré à part de son travail « A year on a Tigris island », publié dans le *Journal of the Bombay Natural History Society*, 1951.

Le Conseil remercie.

Contribution aux Collections :

Monsieur Harry Hoogstraal, de l'U.S. Naval Medical Research Unit N° 3, au Caire, a fait don de deux spécimens d'*Eoctenes intermedius* préparés sur lamelle, et trouvés sur une chauve-souris (*Taphozus perforatus*) aux Pyramides de Ghizeh, le 12 Mai 1950.

Le Conseil remercie.

Démission :

Monsieur le Docteur Assaad Daoud Hanna, résidant actuellement en Angleterre, a fait parvenir sa démission.

Nomination d'un Membre du Conseil :

Conformément à l'article 13 des Statuts le Conseil nomme Monsieur Mahmoud Housny membre du Conseil en remplacement de feu R. Wilkinson. Le mandat de Monsieur Mahmoud Housny prendra fin à l'expiration du mandat de celui qu'il remplace.

Trésorier de la Société :

Le Conseil confie à Monsieur le Docteur Saadallah Mohamed Madwar Bey les fonctions de Trésorier de la Société, en remplacement de feu R. Wilkinson.

Réunion du Conseil du 19 Décembre 1951

Présidence de Monsieur le Professeur H.C. EFFLATOUN Bey,
Vice-Président

Promotion :

Le Conseil félicite notre distingué collègue Monsieur Mahmoud Housny, qui vient d'être nommé Directeur de la Section d'Entomologie du Ministère de l'Agriculture.

Donations :

La Société Royale d'Agriculture et la Société Financière et Industrielle d'Egypte nous ont fait parvenir leur donation annuelle de livres égyptiennes 50 et 15 respectivement.

Le Conseil remercie.

Dons à la Bibliothèque :

La Société a reçu (1) de Monsieur le Docteur Ahmed Salem Hassan, son ouvrage sur l'entomologie appliquée en Egypte, publié en langue arabe (édition 1951) ; (2) de Monsieur le Docteur M.H. Hassanein, un separata de son travail « Studies on the effect of infection with *Nosema apis* on the physiology of the queen honey-bee », publié en Juin 1951 dans le *Quarterly Journal of Microscopical Science*, vol. 92, 2e partie.

Le Conseil remercie.

Coccoidea-Diaspinæ nouveaux du Sud-Est de l'Iran

[Hemiptera]

(avec 4 Planches)

par A.S. BALACHOWSKY,
Institut Pasteur de Paris,

et

M. KAUSSARI,
Ministère de l'Agriculture du Gouvernement Iranien, Téhéran.

L'exploration de la faune des Cochenilles de l'Iran a été activement poursuivie au cours de ces dernières années par les entomologistes iraniens qui ont effectué dans les différentes régions de leur pays de nombreuses et intéressantes récoltes.

L'étude de ces matériaux a déjà fourni un certain nombre d'espèces nouvelles pour la science, découvertes par M. Kaussari, parmi lesquelles nous citerons *Diaspidiotus Kaussarii* Balachw. (1), trouvé sur *Salix* sp. à Abé-Ali aux environs de Téhéran et *Parlagena Mc. Kenzei* Balachw., vivant sur *Tamarix* sp. à Iran Chahre dans le Béloutchistan iranien (2).

Les recherches sur les Cochenilles de l'Iran se poursuivent à l'heure actuelle et, grâce aux matériaux déjà acquis, il sera possible d'entreprendre, à brève échéance, une première étude biogéographique de la faune de ce pays. Cette faune, présente d'autant plus d'intérêt qu'elle se trouve placée à la limite orientale du peuplement paléarctique. Par ailleurs, les recherches effectuées dans les zones désertiques font apparaître l'existence de nombreuses espèces communes, non seulement avec l'Egypte et la Libye mais aussi avec le Nord-Africain.

(1) Balachowsky (A.): Les Cochenilles — Monographie, 2ème partie, p. 494 (Hermann & Cie, édit., Paris, 1950).

(2) Balachowsky (A.): *Rev. Path. Vég. Ent. Agr. France*, XXIX, 1950, p. 17.

Il n'est pas douteux qu'un vaste peuplement nord-néritique s'étend depuis le désert du Sind jusqu'à l'Océan atlantique marocano-mauritanien sans subir de modifications importantes.

Nous nous réservons de revenir sur l'étude biogéographique de la faune coccidologique iranienne ultérieurement ; la présente étude a un but plus limité, elle comprend la description de trois espèces nouvelles appartenant à la sub-famille des Diaspidoidae-Diaspidinae découverts récemment en Iran.

Chortinaspis salavatiani n. sp.

(Planche I)

Bouclier ♀ circulaire, légèrement convexe, d'un blanc pur, mat, pourvu de légères zones concentriques avec l'exuvie larvaire centrale de couleur brune, fréquemment recouverte d'une secrétion écailleuse blanche caduque. 1,8-2,1 mm. (fig. 14).

Puparium ♂ ovalaire, aplati, de même structure que le bouclier ♀.

Micro. — ♀ adulte régulièrement pyriforme ; cuticule cephalothoracique épaissie jusqu'au niveau du segment I de l'abdomen (fig. 1). Mamelon antennaire surmonté d'une soie et pourvu d'un sensoria latéral (fig. 6). Stigmates à pourtour finement spiculé (fig. 7). Tubercule thoracique petit, conique, mais bien visible (fig. 8).

Pygidium obtu, pourvu de 2 paires de palettes bien développées (L_1 et L_2), L_3 nulles.

L_1 robustes mais peu saillantes, arrondies, dépourvues d'encoches latérales, presque symétriques (figs. 2 et 3), très rapprochées l'une de l'autre, laissant entre elles un faible espace médian d'où émergent un ou deux peignes médians très grèles, accolés, étroits, aussi longs que les palettes (fig. 3).

L_2 subtriangulaires, plus courtes que L_1, mais sensiblement de même largeur et faiblement saillantes.

Peignes peu nombreux, grèles, spiniformes ou faiblement denticulés (figs. 4 et 5), au nombre de 1 à 2 entre L_1 et L_2 et de 2 à 3 entre les segments VI-VII.

Absence totale de peignes sur les segments V et VI.

Ouverture anale circulaire de diamètre nettement inférieur à la largeur de L_1 (fig. 2), située au niveau du tiers apical du pygidium.

Macropores dorsaux nombreux, à ouverture petite et subcirculaire, et tubulure filiforme longue (figs. 12 et 13) ; ces glandes sont disposées comme suit :

un groupe submarginal entre les segments VII et VIII (4 à 5 éléments) enfoncés dans une crypte légèrement accusée ;

un groupe de 5 à 6 éléments au-dessus de L_2 ;

un faisceau de 10-12 éléments dans le sillon séparant VI-VII, remontant jusqu'au tiers du pygidium ;

un groupement accessoire sur le segment VI de 5 à 8 éléments ;

un faisceau plus important de 12 à 18 éléments dans le sillon entre V-VI, remontant jusqu'au niveau de l'apophyse latero-basale (fig. 2).

On remarque 4 à 5 éléments au milieu du segment V.

Sur le segment IV et les segments prépygidiaux I à III inclusivement, présence de petits groupements submarginaux de 3 à 12 éléments. Ceux-ci sont également présents sur le bord du métathorax.

Apophyses latero-basale et medio-basale du pygidium bien marquées.

Glandes circumgénitales absentes ; crète paragénitale robuste, longitudinale. Epaississement fusiforme oblique au-dessus de L_2. Face ventrale tapissée de quelques micropores du même type que les macropores dorsaux mais plus réduits (fig. 9), répartis en moins grand nombre et plus irrégulièrement dans l'aire submarginale des segments V-VII et sur les segments prépygidiaux III et IV. On remarque également un groupe accessoire para-médian de 2 éléments sur les segments IV et V.

Remarques. — Espèce très caractéristique du genre *Chortinaspis* Ferris, créé parmi les Aspidiotini-Aspidiotina par Ferris [3] pour un certain nombre d'espèces graminicoles nord-américaines et sonoriennes.

Ce genre comprend actuellement 13 espèces connues [4] dont 3 seulement sont d'origine paléarctique méditerranéenne ou orientale (*Ch. subterraneus* Lindinger, de la région sud-européenne et méditerranéenne ; *Ch. iridis* Balachowsky, de Palestine et Syrie, ainsi que la présente espèce).

Ch. salavatiani se rapproche beaucoup de *Ch. frankliniana* Ferris [5], espèce americano-sonorienne décrite d'El-Paso (Texas) et du Nouveau Mexique, vivant sur *Hilaria cenchroides*, qui possède également un bouclier blanc et une structure pygidiale du même type avec des peignes plus nombreux au pygidium.

Biologie, habitat. — Découvert par Mr. Salavatian à Nahouk (Béloutchistan iranien), Iran, au collet et dans les gaines foliaires des entre-nœuds d'une graminée de grande taille, indéterminée, vraisemblablement d'un *Pennisetum*.

Pseudotargionia orientalis n. sp.

(Planche II)

Bouclier ♀ circulaire ou subcirculaire, faiblement convexe, d'un blanc neigeux, avec l'exuvie larvaire centrale ou subcentrale noire, mais générale-

(3) Ferris (G.F.) : Atlas, SII. 195, 1938.
(4) Ferris (G.F.) : Microentomology (Contrib., N° 51, p. 37, Vol. XI, pt. 2, April 30, 1946).
(5) Ferris (G.F.) : Atlas, SII. 196, 1938.

ment recouverte d'une secrétion blanche caduque (fig. 14), 2-2,3 mm.. Bouclier souvent recouvert par le liège superficiel de l'écorce.

Puparium ♂ de même structure, ovalaire, 1,8 mm.

Micro. — ♀ adulte ovalaire, à cuticule dorsale épaissie chez les individus adultes, entièrement membraneuse chez les jeunes femelles. Cicatrices ovalaires céphaliques absentes. Incision mésothoracique faiblement marquée, peu profonde (fig. 1). Tubercule thoracique petit, pointu, toujours présent (fig. 10). Mamelon antennaire surmonté d'une soie (fig. 8). Stigmates antérieurs pourvus de 4 à 5 glandes peristigmatiques à structure triloculaire (fig. 9), et de 3 à 4 micropores tubulaires accessoires parastigmatiques marginaux. Stigmates postérieurs dépourvus de glandes. Zone postbuccale finement spiculée. Zone céphalique médiane pourvue de 2 groupements de petites glandes tubulaires à conduit extrêmement fin (fig. 5) comprenant 10 à 15 éléments.

Pygidium obtu (fig. 2), pourvu de 2 paires de palettes (L_1, L_2), L_3 nulles ou à peine marquées, irrégulières et asymétriques, L_2 petites, coniques, très rapprochées de L_1 (fig. 3). Entre L_1 et L_2, présence de deux paraphyses, l'une interne (segment VIII) très robuste, claviforme, arrondie, dirigée transversalement, l'autre (segment VII) petite et fusiforme.

Une deuxième paraphyse en forme de sclérose semi-circulaire se trouve l'intersection marginale des segments VI-VII.

Absence totale de peignes sur la marge pygidiale.

Ouverture anale très petite, à peine marquée, ovalaire, à pourtour épaissi, située très bas dans la zone apicale du pygidium à la base de L_1.

Reticulum dorsal bien marqué mais réparti seulement dans la zone médiane du pygidium et n'atteignant pas le niveau anal.

Macropores tubulaires dorsaux du type aspidiotiforme court, avec ouverture ovalaire fortement épaissie (fig. 6), composée d'éléments marginaux sur la bordure pygidiale entre le segment IV et VII, et d'éléments suturaux submarginaux, formant des rangées concentriques au niveau des segments V-VI, IV-V, III-IV, II-III, I-II et le métathorax. Toutes ces rangées glandulaires sont interrompues au niveau de la zone médiane du pygidium (fig. 2). Sur les segments prépygidiaux I-IV inclusivement, présence de rangées transversales de 10 à 12 macropores identiques aux précédents, mais à ouverture ovalaire dépourvue d'épaississement (fig. 12).

Sur le metathorax, ces glandes sont légèrement plus réduites (fig. 11) mais accusent la même disposition.

Glandes circumgénitales absentes. Zone prévulvaire pourvue d'une spiculation granuleuse. Zone circumgénitale légèrement épaissie par une apophyse oblique.

L_1 et L_2 prolongées intérieurement par deux crêtes d'épaississement longitudinales.

Micropores ventraux de même structure que les macropores dorsaux, mais de taille un peu plus réduite (fig. 7), répartis en éléments submarginaux intersegmentaires formant des groupements moins réguliers que ceux de la face dorsale. Absence de glandes medio-ventrales médianes prépygidiales. Zone médiane des segments I-IV spiculée. Marge du pygidium faiblemen incisée (fig. 4).

Biologie, habitat. — Espèce découverte par Mir Salavatian à Nahouk (Béloutchistan iranien), Province de Saravan, sur les parties ligneuses d'une Sapindacée épineuse arborescente, *Stocksia brahuica* (12.iv. 1950).

Remarques. — Le g. *Pseudotargionia*, appartenant à la tribu des Aspidiotini-Pseudaonidina, n'était représenté jusqu'ici dans le monde que par deux espèces vivant sur les *Acacia* épineux, dans la zone saharienne ou nord-tropicale, qui sont *Ps. glandulosa* Newst. (génotype) et *Ps. quadriareolata* Malen.

Ps. glandulosa Newst. (Planche III) est une espèce commune, répandue dans toute la zone saharo-désertique de la mer rouge à l'Atlantique vivant sur divers *Acacia* épineux (*A. raddiana*, *A. seyal*, *A. scropioïdes*), son aire de répartition méridionale s'étend au-dessous de la limite du tropique du Cancer.

Ps. quadriareolata Malen., décrit d'Allengo (Somalie italienne) vivant sur *Acacia asak*, par Malenotti (6) apparait comme extrêmement voisin de *Ps. glandulosa* Newst., mais nous n'avons pu en étudier le type afin d'établir son statut définitif (7).

Le g. *Pseudotargionia* Ldgr. est certainement d'origine tropicale et les espèces répandues dans la région paléarctique ne sont que des éléments avancés de la faune afro-tropicale.

La différence entre *P. glandulosa* Newst. et *P. orientalis* n.sp. s'établit comme suit :

Pseudotargionia glandulosa Newstead (Planche III)	*Pseudotargionia orientalis* n. sp. (Planche II)
Vit exclusivement sur les *Acacia* (Leguminosae).	Vit sur *Stotzi brahuica* (Sapindaceae).
Bouclier ♀ teinté de brun (fig. 12).	Bouclier ♀ blanc neigeux (fig. 14).
Présence de cicatrices ovalaires dorso-céphaliques (fig. 1).	Absence de cicatrices ovalaires dorso-céphaliques (fig. 1).
Absence de tubercule thoracique.	Présence d'un petit tubercule thoracique conique (fig. 10).
Zone cephalo-dorsale pourvue d'un seul groupe de micropores (fig. 5).	Zone céphalique dorsale pourvue de deux groupes de micropores (fig. 5).

(6) Malenotti (E.) : *Redia*, XI, fasc. 2, p. 334, Firenze, 1916.

(7) Ce type a disparu n'existant dans aucune collection italienne ni mondiale.

Stigmates antérieurs pourvus d'un groupe accessoire de glandes tubulaires parastigmatiques de 15 à 20 éléments (fig. 9).	Stigmates antérieurs pourvus d'un groupe accessoire de glandes tubulaires parastigmatiques de 2 à 3 éléments marginaux (fig. 2).
Marge pygidiale fortement incisée (fig. 4).	Marge pygidiale faiblement incisée (fig. 4).
Paraphyse du segment VIII largement fusiforme (fig. 3).	Paraphyse du segment VIII largement claviforme (fig. 3).
L_2 bien développées, arrondies à l'apex et échancrées latéralement, nettement séparées de L_1 (fig. 3).	L_2 réduites, coniques, très rapprochées de L_1 (fig. 3).
Présence constante de peignes.	Absence constante de peignes.
Reticulum dorsal large, étendu jusqu'à l'apex du pygidium (fig. 2).	Reticulum dorsal relativement étroit, s'estompant à partir du 1/3 apical du pygidium (fig. 2).
Macropores tubulaires submarginaux dorsaux du pygidium, disposés en faisceaux (fig. 2).	Macropores tubulaires submarginaux dorsaux du pygidium disposés en une seule rangée par segment (fig. 2).
Absence de macropores tubulaires dorsaux paramédians sur les segments prépygidiaux et le métathorax (fig. 2).	Présence de macropores tubulaires dorsaux paramédians sur les segments prépygidiaux et le metathorax (fig. 2).

Salicicola Davatchi n. sp.

(Planche IV)

Bouclier ♀ rectiligne ou légèrement recourbé, moyennement convexe, étroit ou faiblement élargi vers l'apex. Exuvie larvaire jaune paille, rejetée en avant, secrétion de la femelle blanc pur, mate, avec des zones transversales en léger relief, 1,2-1,4 mm.

Puparium ♂ linéaire, petit, blanc pur, 0,9-1 mm.

♀ adulte, allongée, étroitement ovalaire, rétrécie aux deux extrémités. Cuticle membraneuse, excepté dans la partie medio-ventrale où elle est légèrement épaissie et présente une fine zone de spiculation transversale et dans la zone medio-ventrale où la spiculation est plus fine encore (fig. 1). Mamelon antennaire pourvu de 2 soies très longues et souples (fig. 5). Stigmates antérieurs pourvus d'une seule glande péristigmatique très rapprochée de l'ouverture stigmatique (fig. 6). Glandes ou tubercules glandulaires accessoires parastigmatiques absents. Pygidium raccourci, étroit et semi-circulaire (figs. 2 et 3) à surface dorsale et ventrale membraneuse, mais finement spiculée, totalement dépourvu de toute trace de palettes et de peignes, à marge très finement ondulante, avec quelques soies marginales courtes et espacées.

Ouverture anale de fort diamètre, régulièrement circulaire, et à pourtour épaissi en fer à cheval. Présence de deux épaississements chitineux dans la zone submarginale des segments VII et VIII. Macropores tubulaires dorsaux très peu nombreux, au nombre de 3 de chaque côté, étroits, courts (fig. 4) à ouverture ovalaire marginale peu visible.

Chapiteau à deux couronnes séparées, pourvu d'une tige médiane, filiforme, de même longueur que la tubulure. On trouve 3 macropores margi-

naux à l'exclusion de tout autre éléments glandulaires dans la zone marginale des segments VI-VIII (fig. 3). Ouverture vulvaire très large à pourtour irradié, absence totale de glandes circumgénitales et de glandes tubulaires ventrales. Présence de quelques épines ventrales très courtes, marginales et submarginales comme l'indique la fig. 3.

2ème stade ♀. — Forme largement ovalaire (fig. 7) sans rétrécissement pygidial marqué. Anténnes à mamelon de 4 articles, stigmates antérieurs pourvus de deux glandes peristigmatiques (fig. 12). Pygidium raccourci, non dégagé de l'abdomen (figs. 7 et 8) à ornementation marginale simplifiée par l'absence de palettes nettement différenciées et de peignes, remplacés par une série de mamelons courts, arrondis, irréguliers, situés au niveau des deux derniers segments (figs. 7 et 8).

Ouverture anale circulaire, située nettement au-dessus du milieu du pygidium.

Macropores tubulaires nombreux sur toute la face dorsale et ventrale, depuis le prothorax jusqu'au pygidium, constitués partout d'éléments submarginaux et paramédians, identiques entre eux de taille et de forme (fig. 10). Sur la marge des segments V-VIII de la face ventrale du pygidium, on trouve 8 à 10 macropores (de chaque côté) dont la taille est un peu plus forte et qui sont disposés en éléments accolés par deux ou par trois (figs. 8 et 9).

On remarque également dans la zone submarginale du pygidium quelques taches d'épaississements cuticulaires (fig. 9).

Remarques. — *S. Davatchi* appartient à la tribu des Parlatorini-Leucaspidina, c'est une espèce aberrante n'ayant pas d'affinités avec les autres *Salicicola* paléarctiques. La ♀ adulte, par son pygidium arrondi, dépourvu de toute ornementation marginale, très simplifié dans sa structure, rappelle les caractères du genre *Fissuraspis* Ferris, genre monotypique (*F. ulmi* Ferris) (Atlas S.I. 56, 1937), vivant sur les écorces d'*Ulmus* aux Etats-Unis. Cependant les caractères du 2ème stade ♀ sont totalement différents chez les deux sepèces. Chez *F. ulmi*, il existe des peignes spiniformes acérés médians, divergents (fish tail plates) et latéraux du même type, comme on en rencontre chez les *Pseudoparlatoria* (Diaspidini) ; ces caractères font totalement défaut chez *S. Davatchi*.

Cette espèce diffère des autres *Salicicola* Ldgr. (=*Suturaspis* Ldgr. = *Leucaspidopsis* Ldgr.), par la forme arrondie (et non deltoidale) du pygidium de la ♀ adulte, la faible étendue de la plaque périanale, le petit nombre et la structure très particulière des macropores tubulaires dorsaux (fig. 4).

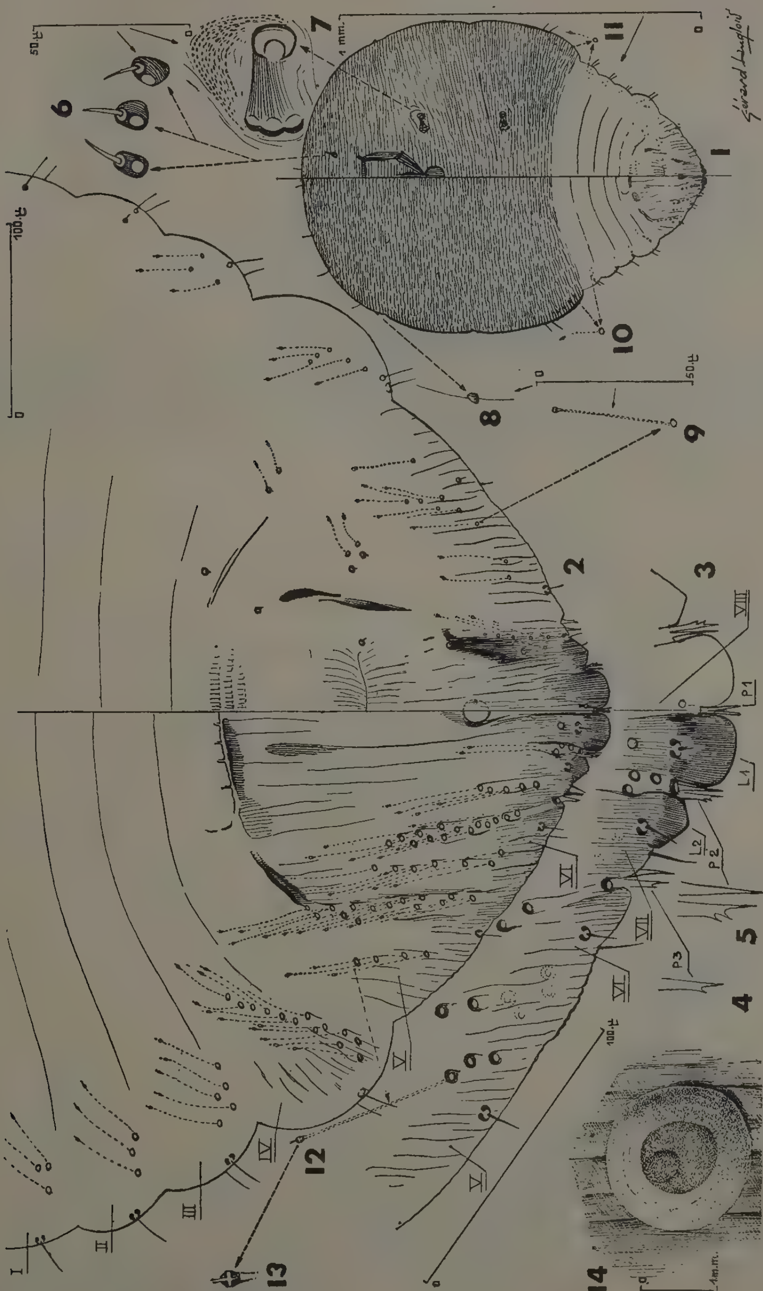
Biologie, habitat. — Cette espèce a été découverte à Saravan (Béloutchistan iranien) par M. Kaussari, vivant sur les parties ligneuses de *Pistacia khindjuk*.

Explication de la Planche I

Chortinaspis Salavatiani n.sp. :

(1) Femelle adulte, aspect général; (2) id., pygidium; (3) id., marge pygidiale; (4) et (5) id., détail des peignes extérieurs; (6) id., antenne et ses modifications; (7) id., stigmate antérieur; (8) id., tubercule thoracique; (9) id., micropore ventral; (10) id., micropore thoracique dorsal; (11) id., micropore thoracique ventral; (12) id., macropore tubulaire dorsal; (13) id., chapiteau de macropore dorsal; (14) id., bouclier de la femelle.

A.S. Balachowsky et M. Kaussari Planche 1



Explication de la Planche II

Pseudotargionia orientalis n.sp. :

(1) Femelle adulte, aspect général; (2) id., pygidium; (3) id., marge pygidiale; (4) id., bordure pygidiale; (5) id., groupement glandulaire céphalique; (6) id., détail d'un macropore dorsal; (7) id., détail d'un micropore ventral; (8) id., antenne; (9) id., stigmate antérieur; (10) id.. tubercule thoracique; (11) id., micropore medio-thoracique; (12) id., micropore medio-vetral prépygidial; (13) id., échelle des figures 3, 4, 5, 6, 7, 9, 10, 11, 12; (14) bouclier de la femelle adulte.

A.S. Balachowsky et M. Kaussari Planche II

Explication de la Planche III

Pseudotargionia glandulosa Newst.

(1) Femelle adulte, aspect général; (2) id., pygidium; (3) id., marge pygidiale; (4) id., bordure pygidiale; (5) id., groupement glandulaire cephalo-thoracique médian; (6) id., détail d'un macropore dorsal; (7) id., détail d'un micropore ventral; (8) id., antenne; (9) id., stigmate antérieur et groupements glandulaires peristigmatiques et parastigmatiques; (10) id., stigmate postérieur; (11) échelle des figures 3, 4, 5, 6, 7, 8, 9, 10; (12) femelle adulte, bouclier.

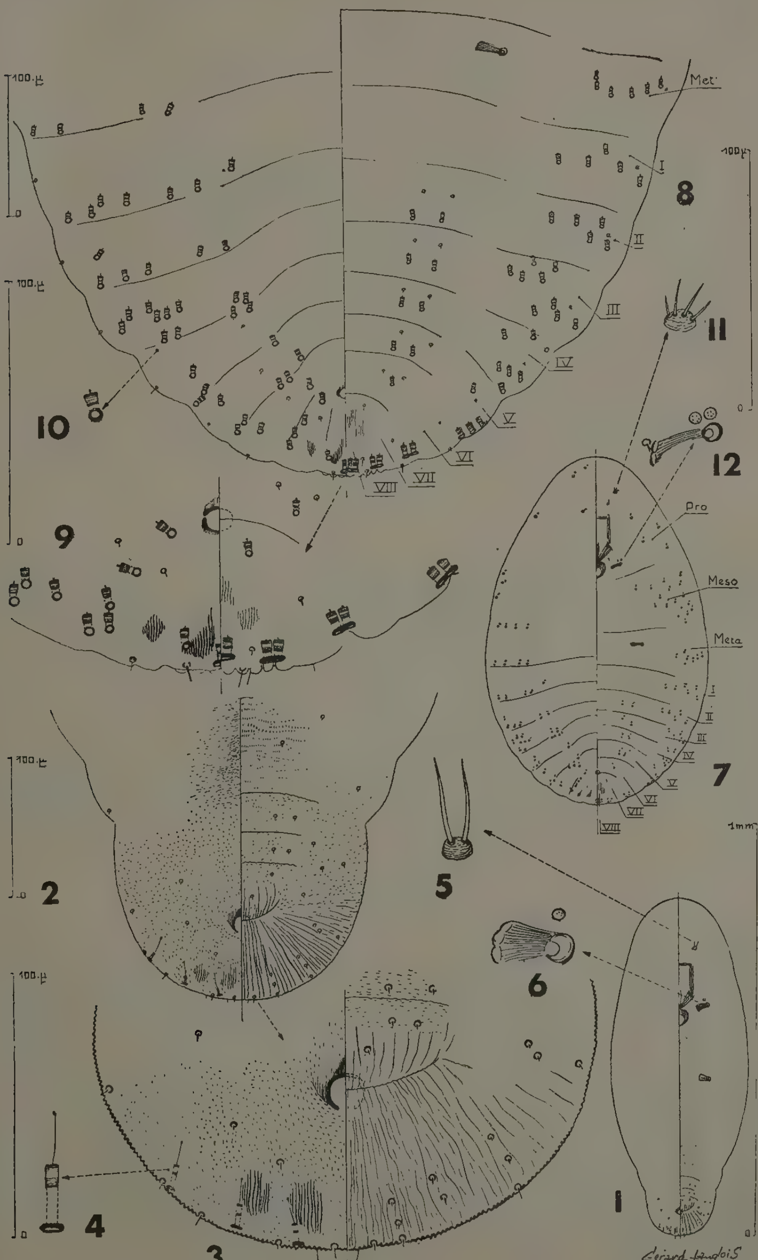
A.S. Balachowsky et M. Kaussari Planche III

Explication de la Planche IV

Salicicola Davatchi n.sp.

(1) Femelle adulte, aspect général; (2) id.. pygidium; (3) id., détail du pygidium; (4) id., glande tubulaire dorsale; (5) id., antenne; (6) id., stigmate antérieur; (7) 2ème stade femelle, aspect général; (8) id., pygidium; (9) id., détail de la marge pygidiale; (10) id., détail d'un macropore dorsal; (11) id., antenne; (12) id.. stigmate antérieur.

A.S. Balachowsky et M. Kaussari Planche IV



The head-capsule and mouth-parts in the Ceratopogonidæ

[Diptera-Nematocera]

(with 109 Text-Figures)

by AMIN M. GAD, Ph. D. (London),
Insect Control Section, Ministry of Public Health, Cairo.

CONTENTS

I. INTRODUCTION

The study of the head-capsule and of the mouth-parts in the Nematocera is of particular interest. Being less specialised in their anatomy, it is easier to establish the homology of parts of this sub-order of the Diptera with those of the other orders of insects, and thus serve as the foundations for the study of the more specialised Muscoid Diptera.

Very few workers on Diptera have studied the head-capsule and mouth-parts of the Nematocera from a comparative point of view. The majority of them have confined themselves to the study of one or a few species only. Thus, *Phlebotomus papatasii* was studied by Adler and Theodor (1926), *Phlebotomus argentipes* by Christophers, Shortt and Barraud (1926), *Culicoides pulicaris* by Jobling (1928), *Anopheles maculi-*

pennis by Robinson (1939), and *Eusimulium lascivum* by Kraftchick (1942).

Among those who have attempted comparative studies, Kellogg (1899) is mentioned as the first pioneer who tried to homologise the mouth-parts of some families of the Nematocera with those of generalised insects and of specialised flies. Peterson (1916) followed by an extensive study of the head-capsule and the mouth-parts of a very large number of generalised and specialised representatives of Diptera. His work is very valuable on account of the numerous diagrams (over 600) it contains, and though his description of the parts may be still regarded as accurate, many of his interpretations are not accepted nowadays.

No attempts were ever made to study and compare the head-capsule and mouth-parts of the genera within a single family of the Nematocera though such a study might reveal certain evolutionary and adaptive tendencies in that family. Hence a study of the head-capsule and the mouth-parts in the Ceratopogonidae has been carried out, and this family was favoured on account of the different habits of feeding among its members.

The Ceratopogonidae (biting midges) were first recognised as a distinct family by Malloch in 1917. In the older systems of classification, they were included with the non-biting midges in the larger family Chironomidae.

Characters differentiating the Ceratopogonidae from the Chironomidae were listed by Edwards (1926), the most important of which may be summarised as follows :

(1) The mouth-parts are complete in the Ceratopogonidae; mandibles are present in both sexes; blade of maxilla present and the third podomere of the maxillary palp has a sense organ.

In the Chironomidae the mouth-parts are reduced; the mandibles absent in both sexes; the blade of the maxilla wanting and the third podomere of the maxillary palp lacking the sense organ.

(2) Vein R 2+3 absent in the Ceratopogonidae, apparently owing to complete fusion with R 4+5. This vein is generally present in the Chironomidae.

(3) The Media is nearly always forked in the Ceratopogonidae but always simple in the Chironomidae.

Edwards (1939) pointed out the fact that the Ceratopogonidae have rather more in common with the Simuliidae than with the Chironomidae. Nevertheless, though a sharp line could be drawn separating the two families, some authors still follow the older classification and name the group the « Ceratopogoninae » as a sub-family of the Chironomidae.

The present work deals in detail with the morphology of the head-capsule and mouth-parts of three representatives of the family having different types of feeding habits : first, *Culicoides impunctatus* Goet., which

sucks blood from man; second, *Atrichopogon* (*Kempia*) *pavidus* Winn., usually found on flowers; and third, *Dicrobezzia venusta* Mg., which is believed to attack other insects. This is followed by a comparative study of the head-capsule and mouth parts of several other species to correlate the form of the mouth-parts with their function. Finally a detailed account of the known feeding habits of the family is given.

II. MATERIAL AND TECHNIQUE

Many of the specimens used in the present study were kindly sent to me by Mr. Downes of the University of Glasgow. Others (*Atrichopogon* and *Schizohelea*) were collected from *Iris* flowers and Umbelliferae. Specimens of *Dicrobezzia* and *Palpomyia* were bred from larvae and pupae found in large numbers on the shore of Loch Lomond in Scotland.

For whole mount preparations of the head and for the dissection of the mouth-parts, insects were soaked in a 5% solution of potassium hydroxide overnight. For the larger insects, it was found preferable to boil them in a water bath for half an hour or more. The specimens were then washed thoroughly with distilled water and were left in Saffranin overnight. Staining in Saffranin as adopted by Peterson (1916) proved to be very useful in differentiating the almost colourless parts. The specimens were dehydrated in alcohol, cleared in clove oil and mounted in Canada-balsam. Clearing in clove oil produced some brittleness which helped in dissecting the parts.

For sectioning the following procedure was followed :

(1) Insects were fixed in Bouin (aqueous or alcoholic solution) for six hours, then with a sharp needle, two or three pricks were made in some not important part of the insect (e.g. side of thorax or abdomen). After that the specimens were left in the same fixative overnight.

(2) Next day they were washed in 70% alcohol for one hour (two changes) and then transferred to 90% alcohol for another hour followed by two changes in absolute alcohol for four hours.

(3) From absolute alcohol the specimens were transferred to a mixture of equal parts of absolute alcohol and ether and were left overnight.

(4) Next morning they were put in a mixture of 4 parts of 0.5% celloidin to one part of cedar wood oil for twenty-four hours.

(5) Each specimen was then put with a small drop of celloidin on a cover-slip, thinly coated with paraffin. The cover-slip, with the specimen, was inverted quickly over a watch-glass containing chloroform. When the celloidin had partly solidified the cover-slip was inverted again, and left in chloroform for half an hour. This was followed by a fresh portion of chloroform for two hours. The chloroform solidified the celloidin and removed the cedar oil.

(6) The small transparent celloidin blocks containing the specimens were transferred to a mixture of equal parts of chloroform and paraffin, and were left on a hot plate overnight.

(7) Finally they were transferred to pure paraffin (two changes) for three hours after which they were embedded.

Transverse sections of the head and mouth-parts were cut about 16 μ thick, but for the study of muscles in longitudinal sections it was found that sections 28 μ in thickness were more satisfactory. The sections were stained with Ehrlichs haematoxylin and counterstained with Eosine.

III. THE HEAD CAPSULE AND MOUTH PARTS IN CULICOIDES IMPUNCTATUS GOET.

(A) The head-capsule

The head-capsule and mouth-parts in *Culicoides pulicaris* L. have been described in detail by Jobling (1928). The details of the structure of the head and mouth-parts of *C. impunctatus* Goet. are not very different from those of *C. pulicaris L.*, but the interpretations of the facts have changed greatly in recent years. Snodgrass (1947) regards this evident stability of the insect structure as compared with the diversity in the written accounts as an illustration of the difference between « anatomy » and « morphology ». Snodgrass conveniently defines anatomy as the facts of structure and, therefore, unchangeable except by the slow process of natural evolution; while morphology is defined as the interpretations of the facts and, therefore, changes with each generation of morphologists, or as often as any morphologist thinks he sees new light on an old subject.

Recently some doubts have been raised on the use of epicranial suture as an important landmark in the anatomy of the insect head. Du Porte (1946) and Snodgrass (1947) assert that this « suture » has no structural significance at all, being merely a line of weakness in the head wall where the cuticle splits at ecdysis, with its arms taking quite different courses in different insects. This claim, whatever support it may gain from anatomical evidence, cannot be regarded as established until evidence is forthcoming as a result of future work on the development of the insect head. Riley (1904), in his account of the embryonic development of the head of *Blatta*, claimed that the Y-shaped epicranial suture results from the dorsal union of the cephalic lobes (vertex, compound eyes, ocular sclerites and genae) forming the coronal stem, and the inclusion within their anterior angle of the procephalic lobe (frons, clypeus and labrum) forming the divergent frontal suture. Unless this statement is disproved, the suggestion that the epicranial suture is a mere cleavage line of ecdysis cannot be regarded as conclusive.

Nevertheless, the criteria given by Snodgrass are of great value in the identification of the regions of the insect head, especially those which lack the whole or part of the epicranial suture, or possess other grooves or lines which could be misinterpreted as the epicranial suture, as in Diptera.

According to Peterson (1916) the arms of the epicranial suture in Diptera, can be traced to their terminal ends near the invaginations of the anterior arms of the tentorium (anterior tentorial pit).

If this is applied to the head of *C. impunctatus* (figs. 1 and 2), the area below these lines would be the fronto-clypeus and the area in between the antennae would be part of the vertex. However, the line extending between the invaginations of the anterior arms of the tentorium corresponds, in generalised insects, to the epistomal ridge or suture (fronto-clypeal suture) and not to the arms of the epicranial suture (frontal suture). Hence the area below the curved lines which start at the anterior tentorial pit, is the clypeal area, and that btween the antennae is the frontal area (labelled clypeus and frons respectively in the figures). This division into clypeal and frontal regions is in accordance with the other criteria put forward by Snodgrass, namely, the origin of the cibarial muscles, and the position of the frontal ganglion, the cibarial muscles having their origin on the clypeal region and the frontal ganglion separating the clypeal muscles from the frontal muscles (fig. 20).

The clypeal region

The clypeal region of the female *C. impunctatus* (fig. 1) consists of a large convex sclerite fused posteriorly with the frontal area, while the anterior border is strongly incurved and is connected with the labrum by two small triangular sclerites, the tormae. The tormae articulate posteriorly with the ventral edge of the clypeal region and the lateral parts of the labrum, and anteriorly with the median part of the labrum (fig. 6). The clypeal region is divided into a large median part and two small lateral parts. On each side of the median part, four long setae are present which are directed anteriorly. The lateral parts of the clypeal region lead posteriorly to the anterior tentorial pits. Fusion has taken place between the lateral parts of the clypeal region and the anterior arms of the tentorium, the lines of fusion being represented on the inner surface of the clypeal region by two prominent apodemes, the clypeal apodemes (fig. 29).

In the male, the clypeal region is not divided into median and lateral parts and it carries only three long setae on the sides. The tormae are attached to the lateral parts of the clypeal region through their entire lengths and are connected with the lateral parts of the labrum (fig. 8).

The frontal region

This is the region between and around the antennal sockets. Posteriorly it is fused to the clypeal region but an imaginary line drawn across the anterior tentorial pits will help in separating the two regions. Anteriorly the frontal region is bounded by the border of the compound eyes.

In the female, two ocelli occur on the frontal region, at the sides of the posterior parts of the two darkly pigmented lines which run in the middle of the head, and curve smoothly towards the invaginations of the anterior arms of the tentorium. The ocelli are in the form of small areas lightly pigmented and surrounded by fine streaks of integument. The two darkly pigmented lines (arms of epicranial suture of Peterson) are really ridges which project as apodemes inside the head and serve for the attachment of muscles. The homology of these ridges or their parts to the cleavage line of the larva or epicranial suture is obscure. Probably these ridges are of secondary origin, as their form and position vary in the different species of the Ceratapogonidae.

In the male (fig. 2) the frontal region is much reduced and very narrow in between the antennal sockets. The ocelli lie at the base of the ridge joining the two compound eyes in the mid-line.

The vertex

The vertex is separated from the frontal region by the borders of the compound eyes. An X-shaped ridge exists at the junction of the two compound eyes dorsally. These ridges project inside the head-capsule as apodemes and serve for the attachment of some of the muscles of the cibarium and the labrum. At the anterior margin of the vertex close to the X-shaped ridge, lies a diamond shaped area with a seta. This area is absent in the male. The vertex bears a number of long setae which are directed forwards. In the male, these setae are less numerous than in the female. Posteriorly the vertex is continuous with the occiput.

The compound eyes

The compound eyes are large, kidney shaped organs occupying the sides and parts of the frontal and posterior surfaces of the head. All the facets are rounded in outline and equal in size. In the male, the compound eyes are narrower in the middle on account of the great development in the first antennal podomere, the scape. They are also slightly displaced laterally and ventrally, so that the head does not look as rounded as that of the female.

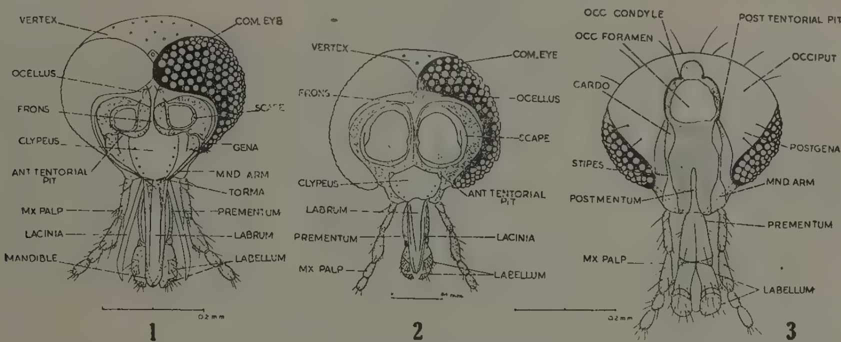
The genae

The genae are represented by two very narrow strips surrounding the frontal and ventral borders of the compound eyes. These strips are continuous with the narrow rims which surround the frontal borders of the compound

eyes. Anteriorly each gena is connected to the anterior tentorial pit by means of a very narrow rod just below the antenna. Attached to the ventral edge of the genae, is a pair of arms which serve for the articulation of the mandibles; the mandibular arms, which are only present in the female (fig. 3).

The occiput and the postgenae

According to Peterson (1916), the occiput is the region dorsal to an imaginary transverse line drawn through the middle of the occipital foramen. The areas ventral to this line and lateral to the median membrane are the postgenae. The occipital foramen occupies roughly a central position. It is formed by a dorsal arch and a ventral arch. The former is narrow



Culicoides impunctatus Goet.

Fig. 1 : Head of female, front view. — Fig. 2 : Head of male, front view. — Fig. 3 : Head of female, posterior view.

and complete, whereas the latter is wide and interrupted ventrally (fig. 3). At the junction of the two arches, there are two small occipital condyles which serve for the articulation with the neck sclerite or latero-cervical sclerite.

The postgenae extend ventrally and surround the ventral arch of the occipital foramen and proboscis membrane, being bound laterally by the compound eyes.

The cervical membrane is attached to the occipital foramen through the thickened lateral edges of the occiput and postgenae and is continuous with the proboscis membrane which occupies the median and lower part of the posterior surface of the head.

The tentorium

The tentorium in *Culicoides impunctatus* is composed of two pairs of cuticular invaginations that unite within the head forming a pair of tubes.

The component invaginations are the anterior arms and the posterior arms of the tentorium. The anterior arms open at the postero-lateral angle of the clypeal region through the anterior tentorial pits (fig. 1). The posterior arms open at the bases of the ventral arch of the occipital foramen through the posterior tentorial pits (fig. 3), and each is associated with the cardo of the maxilla. The dorsal arms of the tentorium are absent in *Culicoides.* They are absent in the majority of the Nematocera, but are represented in *Anopheles maculipennis* by small dorsal spines carried on the anterior arms (Robinson, 1939).

The tentorium serves for the attachment of some of the antennal and maxillary muscles (fig. 21).

(B) The antenna

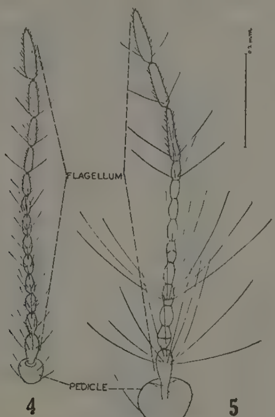
The antenna of the female *C. impunctatus* is of the filiform type, and consists of fifteen podomeres; the scape, the pedicle, and the flagellum which is made up of 13 podomeres. Earlier workers regarded the ring-shaped basal sclerite, the scape (fig. 1) as a detached part of the head-capsule, and therefore claimed that the antenna consists of only 14 podomeres. The study of the antennal muscles, however, reveals that this basal sclerite is a true podomere of the antenna, since some antennal muscles are inserted into it. The scape is rounded and strongly sclerotised. A very prominent process occurs at its posterior border (fig. 1) and a number of setae are present on its outer surface. The scape is attached to the antennal socket by means of a membrane, the base-antennal membrane.

The second podomere of the antenna, the pedicle, is almost globular and is strongly sclerotised (fig. 4). Its surface is covered with fine cuticular spines and bears a few long setae directed forward. At the anterior end of the pedicle there is a depression which serves for the articulation with the first podomere of the flagellum. The pedicle contains a sense organ believed to be auditory in function and is referred to as Johnston's organ. This organ is described in detail by Johnston (1855) for *Culex*, by Miall and Hammond (1900) for *Chironomus*, and by Christophers, Shortt and Barraud (1926) for *Phlebotomus*. It consists of a group of cells arranged radially, with their lower insertion on the wall of the pedicle, and their upper insertion in the membrane between the pedicle and the first podomere of the flagellum.

The flagellum consists of 13 podomeres, the first of which is nearly oval in shape, with the proximal end tapering to fit into the depression of the pedicle. The succeeding podomeres are slightly elongated, each decreasing in length toward the eighth thereafter, then increasing in length towards the terminal podomere. All the podomere of the flagellum are covered with fine spines, and each of the proximal eight carries a whorl of long

setae and two thin-walled seta-like sensillae. The setae on the five terminal elongated podomeres are not arranged in whorls. Scattered over some of the podomeres of the flagellum, especially the more terminal, are a number of small rounded pits, probably olfactory in function.

In the male, the two basal podomeres of the antenna, i.e. the scape and the pedicle, are much larger than those of the female (figs. 2 and 5). The pedicle contains J o h n s t o n's organ which is better developed here



Culicoides impunctatus Goet.

Fig. 4 : Antenna of female. — Fig. 5 : Antenna of male.

than that of the female. The flagellum is composed of 10 ovoid and 3 elongated terminal podomeres. The setae of the former are very long and their thecae are fused together forming a festooned line round the middle part of each podomere which is interrupted, however, on the side of the podomere that is covered with fine spines (shown in the 6th podomere of the flagellum, fig. 5). Anteriorly, each of these podomeres carries two or three seta-like sensillae. The setae on the three terminal podomeres are short and not arranged in whorls.

(C) The mouth-parts

The mouth-parts of the female are adapted for piercing and sucking. The piercing apparatus consists of a labrum, a pair of mandibles, a pair of maxillae and a hypopharynx. The sucking apparatus consists of a cibarial and a pharyngeal pump. A labium is present but, as will be shown later, is not a piercing organ, but serves as a guide to the piercing stylets.

In the male, the mouth parts are complete and similar in construction to those of the female, but the degree to which the labrum, mandible, maxilla and hypopharynx are developed as cutting appliances is much less.

The labrum

The labrum of the female *C. impunctatus* is dagger-shaped, armed anteriorly with six terminal and 12 lateral teeth (fig. 6). The terminal teeth are in two groups of three each with a small median notch in between (fig. 7). Six lateral teeth occur on either side of the tip of the labrum and are directed anteriorly.

The labrum consists of four parts best seen in transverse sections of the mouth-parts (figs. 24-27) ; a median part, two lateral parts, and a posterior membraneous part often called the « epipharynx ». Consequently the whole organ has been referred to by most workers of Diptera as the « labrum epipharynx ». The tranverse sections show, however, that the posterior surface of the labrum is smooth and presents no structure of any kind to be specifically termed an epipharynx. This agrees with Snodgrass (1937) and Robinson (1939), the latter in his study of the mouth-parts of *Anopheles maculipennis* rejected the dual conception and nomenclature.

The median part of the labrum is convex and darkly sclerotised. Anteriorly it bears the terminal or median teeth. Posteriorly it is attached to the clypeal region by the tormae (fig. 6). At the junction of the labrum with the tormae, the median part of the labrum extends inside the head-capsule, as a long process, the posterior process of the labrum which serves for the attachment of the labral muscles.

The lateral parts of the labrum are rod-shaped and their anterior edges are curved, bearing the strong lateral teeth. The convex toothed margin extends posteriorly as a long tooth-like spine which is weakly sclerotised and directed backwards. In transverse sections of the mouth-parts (figs. 25-27), the lateral parts of the labrum were found to be thick, darkly sclerotised occupying a level ventral to the dorsal part of the labrum to which they are attached by membranes.

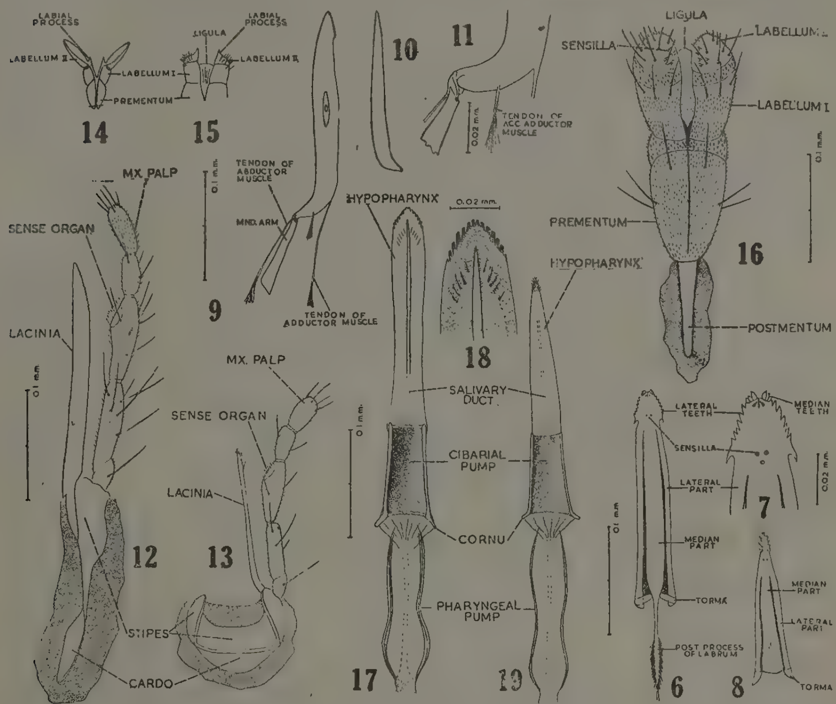
The posterior wall of the labrum, arises from the antero-dorsal part of the cibarial pump (fig. 28). At the anterior end of the labrum, the posterior part is fused with the dorsal and lateral parts (fig. 24). In the middle of the narrow part near the tip of the posterior wall, there are three sensory spots (sensillae) arranged in a triangle (fig. 7).

The labrum of the male (fig. 8) is two-thirds the length of the female, but consists of the same four parts. Its anterior end, however, tapers to a point and carries a number of small short bristles.

The mandibles

Each mandible consists of a long blade which is bent at each end but in opposite directions (fig. 9). The anterior end is bent inwards (towards the other mandible) and the posterior end outwards. The margin of the curved anterior end is toothed, and when at rest, the toothed edge of the

left mandible projects slightly beyond the right antero-lateral part of the labrum (fig. 1), while the toothed edge of the right mandible projects beyond the left antero-lateral part of the labrum. The number of teeth carried on



Culicoides impunctatus Goet.

Fig. 6 : Labrum of the female. — Fig. 7 : Anterior end of same. — Fig. 8 : Labrum of the male. — Fig. 9 : Mandible of the female. — Fig. 10 : Mandible of the male. — Fig. 11 : Base of mandible of the female. — Fig. 12 : Maxilla of the female. — Fig. 13 : Maxilla of the male. — Fig. 14 : Labium of *Asyndulum montanum* (after I m m s, 1944). — Fig. 15 : Labium of *Dixa* spec. (after I m m s, 1944). — Fig. 16 : Labium of female, ventral view. — Fig. 17 : Hypopharynx and sucking apparatus of the female. — Fig. 18 : Anterior end of the hypopharynx of the female. — Fig. 19 : Hypopharynx and sucking apparatus of the male.

the curved anterior end of the mandible is 14, and this was constant in all specimens examined. The teeth are all equal in size and in this respect they resemble those of *C. vexans* but differ from those of *C. pulicaris* and *C. obsoletus* where the apical teeth are the largest, and the posterior teeth the smallest (J o b l i n g, 1928).

The middle of the mandible is slightly broader than at either end, and in this region there is a spindle-shaped depression with a darkly pigmented

ovoid body in the middle or slightly to one side. Christophers, Shortt and Barraud (1926) referred to a similar structure on the mandible of *Phlebotomus argentipes* but they failed to explain its significance. Jobling (1928) described this structure in *Culicoides pulicaris* L. and attributed its presence to a median depression on the dorsal surface of each mandible in the form of a spindle and that under each depression on the ventral surface there is a strongly sclerotised process. In a transverse section of this region (fig. 26), it is seen that the process of the left mandible (which always lies above the right) interlocks with the depression on the dorsal surface of the right mandible, and the process of the latter interlocks with the lumen of the salivary duct of the hypopharynx. By this mechanism the mandibles are held tightly together like the blades of a pair of unopened scissors.

The posterior part of the mandible has a thick base which articulates with the mandibular arm by means of two processes (fig. 11) : a hook-shaped process that fits into the socket of the mandibular arm, and a short process fused to the ventral surface of the hook-shaped process. From this small process arises the tendon of the abductor muscle of the mandible. The inner edge of the mandible gives off a similar tendon, that of the adductor muscle, while a third short tendon, belonging to the accessory adductor muscle arises in between the other two tendons.

The mandible of the male is shorter and much less sclerotised than that of the female. Its tip tapers anteriorly to a point but lacks teeth. The spindle and the dark ovoid spot are absent in the mandible of the male.

The maxilla

The maxilla in Diptera consists typically of cardo, stipes bearing a single lobe and a maxillary palp. Peterson (1916) observed the constant close association of the cephalic articulation of the basal parts of the maxilla with the posterior tentorial pit.

The single lobe of the maxilla was generally interpreted, by all students of Diptera, as the galea ; the lacinia having atrophied. Imms, (1944) from the study of the muscles of the maxilla in some representatives of the Nematocera and the Brachycera, found evidence that the maxillary lobe is, in all probability, the lacinia and not the galea.

In generalised insects the lacinia is provided with two muscles inserted on its basal part ; one is the cranial flexor arising on the top of the head and the other is the stipital flexor arising on the stipes. The galea is provided with one muscle only, the flexor of the galea, arising on the stipes. Imms showed that the maxillary lobe in *Tabanus* is supplied with a retractor muscle arising on the occiput (which is the homologue of the cranial flexor of generalised insects) and therefore should be regarded as the lacinia and not the galea. He also showed that among the Nematocera, the retractor

of the lacinia tends to shift its origin from the primitive position on the head wall to the tentorium.

In *C. impunctatus*, the cardo and the stipes are embedded in the median membraneous area ventral to the occipital foramen and occupying lateral positions (fig. 3).

In the female, the cardo is paddle shaped, and its proximal end is associated with the posterior tentorial pit (fig. 3). Its distal end is fused with the stipes (fig. 12) which is large and broad and is fused anteriorly with a process at the base of the lacinia, the posterior process of the lacinia.

The lacinia is as long as the mandible but is rather narrower. Its distal end bears on its outer side 16 tooth-like processes directed backwards. Transverse sections (figs. 24-27) show that the dorsal surface of the lacinia is membraneous while the ventral surface is sclerotised.

The maxillary palp consists of five podomeres, the surface of which is covered with spines and bears moderately long setae. The first podomere is small and triangular in shape, only its outer surface being sclerotised, while the inner surface is membraneous and is attached to the second podomere. The second podomere, the largest one in the palp, is cylindrical and joined to the third by a membraneous joint. The third is asymmetrical on account of a unilateral dilation near the anterior end at the side facing the lacinia. On this area a group of small hair-like knobbed sensillae is present. It is interesting to notice that sense organs carried on the third podomeres of maxillary palpi exist in other families of Nematocera and also in some Mecoptera (Crampton 1923, and Imms 1944). This may confirm the conception now held by most entomologists, that the Mecoptera are the nearest ancestral types of the Diptera.

The fourth and fifth podomeres of the palp are short. A palpifer is absent in *Culicoides*.

In the male, the cardo and the stipes are fused mesially with the corresponding parts of the other side (fig. 13). The cardo is lens-shaped, straight anteriorly and convex posteriorly. The stipes is U-shaped and carries the lacinia which is poorly sclerotised and bears few bristles at its tip. The maxillary palp is shorter than that of the female and bears fewer setae.

The labium

The labium in Nematocera consists of prementum and postmentum together with a pair of two-segmented labella. The homology of the parts forming the labium, especially the labellum has caused a considerable divergence of opinion. According to one school (Peterson (1916), Otanes (1924), MacGillivray (1924) and Hansen (1930), the labellum is the modified and enlarged paraglossa. The other school (Frey (1913), Crampton (1921, 1923, 1925), Jobling (1928), Tillyard (1926), and Weber

(1933)) maintain that the labellum is a modified labial palp. This latter view is supported by the following observations :

(1) In no order of insects does the paraglossa become divided into two parts.

(2) The Mecoptera (the neaerest living representatives of types ancestral to the Diptera) have two segmented labial palpi, and there is no indication that the paraglossae are ever retained at all — much less that they will become enormously developed, nor is there any indication that the labial palpi will completely disappear. In fact the distal segment of the labial palp in certain Mecoptera, e.g. *Nannochorista dipteroides*, may even become membraneous and labellum-like and may even, according to Tillyard, exhibit pseudotrachea similar to those occurring in the labella of Diptera.

(3) In all relatives of Diptera viz. Trichoptera, Lepidoptera, and Aphaniptera, the paraglossa is lost while the labial palpi are always retained.

(4) The tendency in other holometabolous insects, e.g. Coleoptera and Hymenoptera, is towards reduction of the paraglossa.

All these arguments, however, do not take into consideration the musculature of the labium which is certainly more decisive. Snodgrass (1935) criticizes Crampton's homologizing the labella with the labial palpi because « the lobes of the fly-labium have usually each only one muscle inserted upon it », whereas palpi usually have antagonistic muscles. Evidence, however, has accumulated showing the existence of antagonistic muscles within the labella as in typical palpi (Vogel (1920), Jobling (1928), Robinson (1939), and Imms (1940)). As will be shown below, the present work confirms this view.

A small median lobe is often present in between the labella in Nematocera and is usually termed the ligula. Those writers who homologize the distal lobes of the labium as paraglossa claim that this structure represents the fused glossae. Most members of the other school of thought homologize the ligula with the paraglossae. Crampton, however, considers it a new formation composed of the union of two small lobes arising on the inner side of the palpi as in *Asyndulum montanum* (fig. 14), a mycetophilid fly. Imms (1944) discards this view, since similar labial processes, though terminal, exist in *Dixa* (fig. 15) together with the median lobe. It seems probable that the median lobe is merely an outgrowth of the membrane between the labial palpi. The term « ligula » will be retained in the present work to describe this median lobe irrespective of its doubtful homology.

In *Culicoides impunctatus*, the postmentum is in the form of a triangular sclerotised sclerite embedded in the membraneous area ventral to the occipital foramen (fig. 3) median in position, in between the stipes of the maxillae. Seen in lateral view (fig. 20) the postmentum is bow-shaped with a broad anterior end and a blunt narrow posterior end. To the anterior end

is attached the prementum (fig. 16), often called the « theca », which is the largest part of the labium. The prementum is slightly broader anteriorly than posteriorly. On its ventral surface, which is covered with small spines, the prementum bears four long setae carried postero-laterally and two near the anterior end medially. Seen in transverse sections (figs. 26 and 27) the prementum is sclerotised ventrally while the dorsal surface is membraneous. The ventral surface carries an internal carina or ridge (fig. 27) formed by the inflection of the walls of the two components of the prementum, which are fused ventrally along the mid-line.

The labellum or labial palp consists of two podomeres. The basal podomere is the larger, and is attached to the anterior end of the prementum by a membrane (fig. 16). The surface of the labella is covered with spines and bears numerous long setae. Five gustatory sensillae are present on the terminal podomeres of each labellum. In transverse sections (fig. 25) the podomeres of each side are seen to be fused dorsally having a common dorsal membraneous wall. Ventrally they are separated by the ligula which becomes free from the labial palp at the anterior end of the labium (fig. 24). In this region the walls of the second podomeres of the labella are thin, and much folded at the sides.

The labium of the male is shorter than that of the female. The theca and labella are similar in structure to those of the female whereas the postmentum is very reduced.

The hypopharynx

The hypopharynx of the female *C. impunctatus* is represented by a blade-like structure which springs from the floor of the cibarial pump. It is a bilaterally symmetrical organ (fig. 17), equal in length to the labrum and lying in apposition to it. At the base, the hypopharynx is thick and broad, but towards the middle, it narrows a little and then again increases in breadth towards the anterior end. The tip of the hypopharynx is furnished with seven strong teeth on each side (fig. 18). The posterior third of the hypopharynx is perforated by the salivary duct which is continued anteriorly as a median groove (see also figs. 24-28).

The hypopharynx of the male is one third shorter than that of the female (fig. 19). Its tip, which is poorly sclerotised, is devoid of teeth but carries a few short bristles.

(D) The sucking apparatus

In Nematocera, the sucking apparatus consists of two chambers; one lies in the clypeal region, the other in the back part of the head. There has been much controversy as to the nomenclature of these chambers. Peterson (1916) called the former the basipharynx and the posterior

chamber the oesophageal pump. Patton and Evans (1929) recognised three parts : prepharynx and midpharynx for the anterior chamber, and postpharynx for the posterior chamber. Some writers, however, following Nuttall and Shipley (1901-1903) term the first part, the buccal cavity and the second the pharynx. The cause of this controversy seems to be the different interpretations of the homology of the muscles of these parts. Snodgrass (1935 and 1944) has shown that the clypeal dilators of the first chamber are homologous with the clypeal dilators of the cibarium in generalised insects such as the cock-roach. This chamber should therefore now be regarded as the cibarial pump. The posterior chamber has been shown to be a modification of the pharynx and may be referred to as the pharyngeal pump.

The cibarial pump

The cibarial pump is a wide tube occupying a median and nearly vertical position inside the head-capsule (fig. 20). It is connected anteriorly with the posterior wall of the labrum and the hypopharynx (fig. 28). In transverse sections the buccal cavity is seen to have a dorsal membraneous wall and ventral and lateral sclerotised walls (fig. 29). At its posterior end, the dorso-lateral walls are produced into two projections which curve dorsally, the cornuae (fig. 17). According to Snodgrass (1944), the cornuae in Nematocera are homologous with the oral arms of the hypopharynx in generalised insects since they carry homologous muscles.

The pharyngeal pump

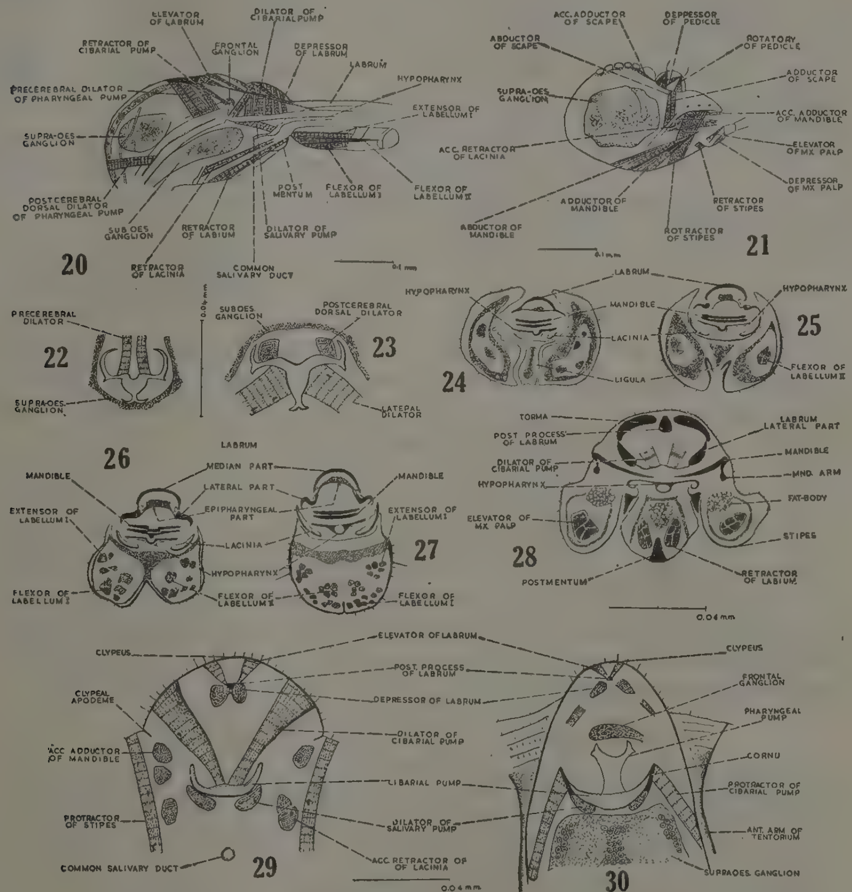
The pharyngeal pump lies inside the head-capsule, between the supra-œsophageal and the sub-œsophageal ganglia (fig. 20). It is shaped somewhat like a spear-head, narrow anteriorly and wider posteriorly being constricted in the middle (fig. 17). The structure of this pump is best understood by the study of transverse sections where it is seen to be composed of 3 plates, one dorsal and two lateral (figs. 22 and 23) arranged in the form of a triangle. Each plate is thicker in the middle than towards the edges. The plates are continuous with each other through three small E-shaped. sclerotised bands. The dilator muscles of the pharyngeal pump are attached to the dorsal and lateral plates.

The sucking apparatus of the male is formed from the same parts as those of the female, though in the male they are less developed. The cornuae of the cibarial pump are directed laterally.

The salivary pump

The salivary pump in *C. impunctatus* is formed by the anterior part of the common salivary duct with the posterior ventral part of the hypopharynx (fig. 20). Its ventral wall is sclerotised while the dorsal wall is

membraneous to which the dilators of the salivary pump are attached. The lumen of the salivary pump is continued anteriorly as the hypopharyngeal salivary duct.



Culicoides impunctatus Goet.

Fig. 20: Longitudinal section through the middle part of the head of female. — Fig. 21: Longitudinal section through the lateral part of the head of female. — Fig. 22: Transverse section through the anterior part of the pharyngeal pump. — Fig. 23 : Transverse section through the posterior part of the pharyngeal pump. — Fig. 24 : Transverse section through the second podomera of the labella. — Fig. 25 : Transverse section through the first podomera of the labella. — Fig. 26 : Transverse section through the middle of the month-parts. — Fig. 27 : Transverse section through the posterior part of the mouth-parts. — Fig. 28 : Transverse section through the base of the mouth-parts. — Fig. 29 : Transverse section through the middle of the clypeal region. — Fig. 30 : Transverse section through the posterior part of the clypeal region.

(E) The muscles

(a) Muscles of the antenna (fig. 21)

(1) Adductor of the scape : a small muscle arising on the anterior part of the anterior arm of the tentorium to be inserted into the lower inner edge of the anterior part of scape.

(2) Abductor of the scape : similar to the adductor and originating just posterior to it on the anterior arm of the tentorium to be inserted into the lower outer edge of the anterior part of the scape.

(3) Accessory adductor of the scape : this small muscle takes its origin on the apodemes of the frontal region and is inserted into the lower inner edge of the posterior part of the scape.

(4) Depressor of the pedicle : a fan-shaped muscle arising from the posterior process of the scape to be inserted into the lower anterior edge of the pedicle.

(5) Rotators of the pedicle : small bands of muscles which take their origin on the lower edge of the inner surface of the scape and are attached to the lower edge of the inner surface of the pedicle.

The flagellum is not provided with muscles.

(b) Muscles of the labrum (figs. 20 and 29)

(1) Elevator of the labrum : a group of paired bands of muscles arising on the clypeal region and the apodemes of the frontal region, and converge to be inserted into the posterior process of the labrum, dorsally.

(2) Depressor of the labrum : a pair of muscles arising on the ventral side of the posterior process of the labrum and inserted into the posterior end of the epipharyngeal part of the labrum.

(c) Muscles of the mandible (fig. 21)

(1) Adductor of the mandible : a powerful muscle that takes its origin on the lower part of the postgena.

(2) Accessory adductor of the mandible : a small muscle arising on the lateral part of the clypeal region (fig. 29).

(3) Abductor of the mandible : a muscle similar to the adductor in size and originating on the postgena posterior to the adductor.

These muscles are inserted onto their corresponding tendons of the mandible already described (figs. 9 and 11).

(d) Muscles of the maxilla (fig. 21)

(1) Protractor of the stipes : very strong muscles which arise on the lateral part of the clypeal region and pass backward to be inserted to the posterior part of the stipes (fig. 29).

(2) Retractor of the stipes : a very small muscle originating on the edge of the gena and inserted into the middle part of the stipes.

(3) Retractor of the lacinia : originating on the posterior arm of the tentorium and inserted ventrally into the posterior process of the lacinia.

(4) Accessory retractor of the lacinia : originating on the anterior arm of the tentorium and inserted into the posterior process of the lacinia dorsally.

(5) Elevator of the maxillary palp : a small muscle arising from the middle part of the stipes and inserted on the dorsal side of the posterior end of the first podomere of the maxillary palp.

(6) Depressor of the maxillary palp : small muscle similarly originating on the stipes and inserted onto the ventral side of the posterior end of the first podomere of the palp.

(e) Muscles of the labium (figs. 20 and 27)

(1) Retractor of the labium : paired muscles that take their origin on the postgenae near the margin of the occipital foramen, and inserted on the base of the prementum.

(2) Flexors of the labella : paired muscles that arise on either side of the postero-ventral part of the prementum and inserted into the ventral part of the posterior end of the first podomere of the labella.

(3) Extensors of the labella : similar paired muscles arising on the base of the prementum above the flexors and inserted onto the postero-lateral part of the first podomere of the labella.

(4) Flexors of the second podomere of the labella : long paired muscles, also originating at the base of the posterior end of the prementum, and inserted into the postero-lateral part of the 2nd podomere of the labella.

(f) Muscles of the cibarial pump

(1) Dilators of the cibarial pump (figs. 20 and 29) : these are paired muscles, six on each side which arise on the roof of the clypeal region near the middle line and inserted into the membraneous dorsal wall of the cibarial pump.

(2) Retractors of the cibarial pump (fig. 20) : these are strong muscles originating on the apodomes of the frontal region and inserted into the apex of the cornu of the cibarial pump.

(3) Protractors of the cibarial pump (fig. 30) : a pair of small but stout muscles arising on the posterior part of the clypeal apodeme near the anterior tentorial pit and inserted into the ventral surface of the cornu of the cibarial pump.

(g) Muscles of the pharyngeal pump

(1) Precerebral dilators of the pharyngeal pump (figs. 20 and 22) :

paired bands of muscles arising on the apodemes of the frontal region and inserted into the anterior part of the dorsal plate of the pump.

(2) Postcerebral dorsal dilators of the pharyngeal pump (figs. 20 and 23) : a pair of strong bands of muscles arising on the occiput to be inserted into the posterior part of the dorsal plate of the pharyngeal pump.

(3) Lateral dilators of the pharyngeal pump (fig. 23) : paired bands of muscles arising on the edge of the postgenae and inserted into the posterior parts of the lateral plates of the pharyngeal pump.

(h) Muscles of the salivary pump

Dilators of the salivary pump (fig. 20) : small paired bands of muscles arising on the postero-lateral parts of the cibarial pump and attached to the dorsal surface of the salivary pump.

(F) The mechanism and effect of piercing

Female specimens of *Culicoides* belonging to the species *C. obsoletus* and *C. chiopterus* were collected and kept, in sample tubes, each of which was provided with a strip of filter paper. The insects were given, at first, a drop of sugar solution on the filter papers, and on every subsequent day, the filter papers were moistened with water to maintain a suitable degree of humidity. In this way *Culicoides* could be kept alive for a period as long as 20 days.

For observing the mechanism of piercing, the tube containing the insect was inverted over a shaved area of the forearm and if the insect started piercing the skin, the tube was removed and the process observed under a previously adjusted travelling binocular.

It was found that, at first the *Culicoides* crawled for a while over the forearm, its abdomen making an angle of less than 45° with the surface of the forearm and the proboscis directed at right angles with the axis of the body. During this period the maxillary palpi were very active, moving upward and downward. When the midge has chosen its piercing spot, its body assumed an almost parallel position to the surface of the forearm with he mouth-parts held vertically.

The labrum, the hypopharynx and the mandibles lying in-between acted together and showed a rhythmic movement of protraction and retraction. It was found that the mandibles remained locked together by means of the structures present on the middle of their ventral surfaces already described in connection with the morphology of the mandibles. Their anterior ends cross over each over, thus the toothed edge of the left (upper) mandible lies to the right, and that of the right (lower) mandible lies to the left and the two toothed edges project slightly beyond the lateral teeth of the labrum. The mandibles, combined with the labrum, which is provided with median

and lateral teeth at its anterior end, and the serrated hypopharynx form a very efficient piercing organ, and, as could be expected from its structure and arrangement of its components, the protraction and retraction of this organ produced an immediate « cut » in the skin through which the stylets penetrated.

It was not at all easy to determine which of the piercing stylets penetrate the skin first, on account of the very small size of the insect and the rapidity with which this phase of the process was accomplished.

Protraction and retraction ceased only when these stylets have penetrated a little more than half their length. The laciniae of the maxillae could not be seen during the piercing process as they are masked by the other mouth-parts, besides being weakly pigmented. Their musculature, however, might indicate that their action is also of retraction and protraction by the two retractor muscles of the lacinia and the strong protractor muscle of the stipes. During the process of piercing, the maxillary palpi stopped moving and remained stretched to the sides till the end of the process. When piercing is completed, blood-sucking begins, but the action of the cibarial and pharyngeal pump is not betrayed externally. It may be assumed, as in mosquitoes, that their respective expansions and contractions have opposite rhythms, one contracting as the other expands, so as to give a continuous flow to the stream of liquid food coming through the food canal which is formed between the left (upper) mandible and the labrum (fig. 26).

The role of the labium in the process, is mainly to act as a guide to the other stylets. The labium is not a piercing organ and does not enter the wound. When the piercing stylets start protracting and retracting, the labella bend backward and the theca is retracted by the action of its own muscles, so that the labium becomes gradually shorter, enabling the other mouth-parts to penetrate the skin.

When the insect is sucking, its abdomen is seen to become gorged with blood in a few seconds.

The whole process of feeding takes from 3-4 minutes after which the mouth-parts withdraw from the puncture leaving a small drop of blood round which a small red spot is gradually formed and this may last for more than a week.

To the writer the « bite » and the red spot which afterwards formed, were quite painless and never caused any disagreeable sensations. This confirms the general conception that some people are more susceptible subjects to « bites » of midges (or mosquitoes). Jobling (1928) dscribed the irritation caused by *Culicoides* (which was accompanied by an oedematous swelling) as intense, starting from the moment of piercing and lasting from one to several days.

It was found also that many *Culicoides*, known to be « blood-thirsty », though given several chances, refused to feed on the forearm while some fed quite readily. The reason for this behaviour may lie in the general belief that a blood meal is taken by the female midge only after it has copulated with a male, and, therefore, those which refused it may have been caught before they had ever had any chance of copulating. This view, however, needs further confirmation.

IV. THE HEAD-CAPSULE AND MOUTH-PARTS IN ATRICHOPOGON (KEMPIA) PAVIDUS (WINN.)

Atrichopogon (*Kempia*) *pavidus* Winn. belongs to a different group of the Ceratopogonidae with regard to its feeding habits. Both sexes are found in large numbers on honey-suckle and *Iris* flowers. The question arises, however, whether these insects are actually nectar-feeders or whether they are « predaceous » on other small insects that may visit those flowers.

The anatomy of the mouth-parts of *Atrichopogon pavidus*, as will be shown later, favours the view that they are actually nectar-feeders.

(A) The head-capsule

There is hardly any difference in size, or in the details of anatomy, between the head of the female and that of the male of *A. pavidus*.

The clypeal region

The clypeal region (fig. 31) is in the form of a single median plate which lies almost completely below the level of the posterior ends of the compound eyes. On its inner surface the clypeal region is provided with a pair of apodemes similar to those found in *C. impunctatus*, the clypeal apodemes. These apodemes, however, do not divide the clypeal region externally into median and lateral parts. The clypeal region carries 12 long setae arranged in the female as shown in fig. 31.

The tormae are absent in *A. pavidus*, and the clypeal region is fused wih the lateral parts of the labrum (figs. 49 and 50).

The frontal region

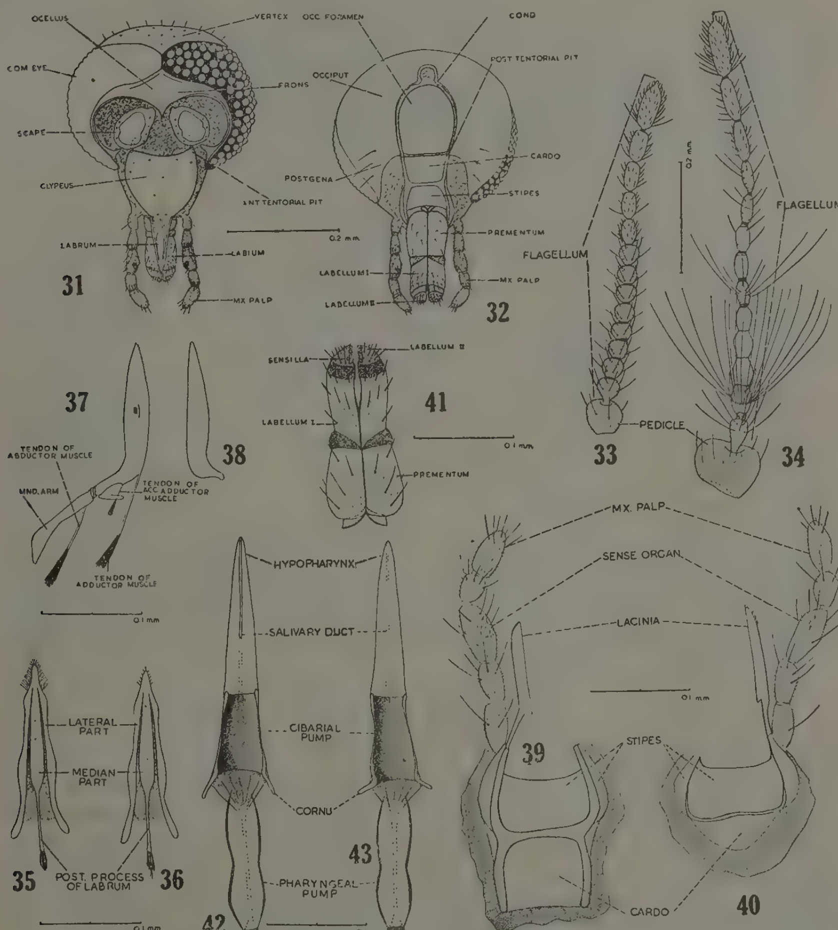
The frontal region is reduced owing to the great development of the membraneous areas surrounding the two scapes and their fusion in the middle line. Thus the frontal region is restricted to that part between the edge of the compound eyes postriorly and the membraneous area, anteriorly. In the middle of the frontal area, on either side of the middle line, lie the ocelli, similar in outline to those already described in *Culicoides*.

Other parts of the head-capsule, namely the vertex, occiput, and the postgena, occupy the same relative positions as in *Culicoides*. The postgena

carries a number of long setae, and a wide membraneous area separates the postgena from the basal parts of the maxilla and labium (fig. 32).

The tentorium

Two pairs of arms of the tentorium are present within the head-capsule of *A. pavidus*, similar to those in *Culicoides*. The anterior pair opens



Atrichopogon (Kempia) pavidus (Winn.)

Fig. 31 : Head of female, front view. — Fig. 32 : Head of female, posterior view. — Fig. 33 : Antenna of female. — Fig. 34 : Antenna of male (setae not shown on some podomeres). — Fig. 35 : Labrum of female, — Fig. 36 : Labrum of male. — Fig. 37 : Mandible of female. — Fig. 38 : Mandible of male. — Fig. 39 : Maxilla of female. — Fig. 40 : Maxilla of male. — Fig. 41 : Labium of female. — Fig. 42 : Hypopharynx and sucking apparatus of the female. — Fig. 43 : Hypopharynx and sucking apparatus of the male.

by the anterior tentorial pits, which lie just below the base of the antennae (fig. 31). The posterior pair open through the posterior tentorial pits on the posterior surface of the head below the occipital foramen (fig. 32), and are associated with the posterior ends of the cardines of the maxilla.

(B) The antenna

The antenna in *A. pavidus* consists of the same number of podomeres as in *Culicoides :* scape, pedicle and a flagellum consisting of 13 podomeres. The antenna of the male is much longer than that of the female.

The scape is ring-shaped (fig. 31), with two small processes on the inner sides and a prominent posterior process. In the male the scape is larger and occupies most the membraneous area that lies in between the lateral edges of the compound eyes on the frontal side of the head.

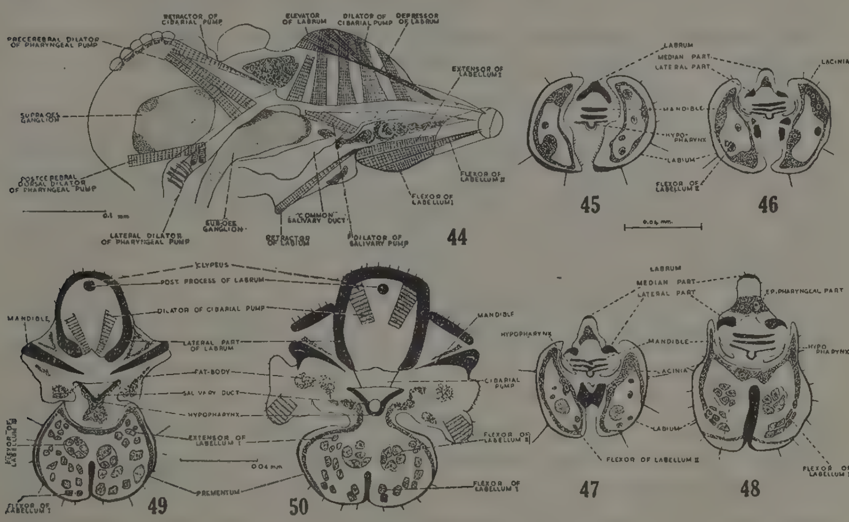
The pedicle which is attached to the scape by a wide membrane, is much larger in the male than in the female (figs. 33 and 34). In both sexes they are covered with very minute scales and bear few long setae and are provided with a funnel-like depression at their anterior end which serves for the reception of the first podomere of the flagellum.

The first podomere of the flagellum is globular in the female, but tapers posteriorly to fit in the depression of the pedicle. This podomere is followed by seven more-or-less spherical podomeres decreasing slightly in size towards the apex of the flagellum, the largest podomere being adjacent to the pedicle. These podomeres of the flagellum are attached to each other by distinct membranes. Their surfaces are covered with small spines and bear long seta which are slightly longer than the podomeres. The setae are carried in whorls of about seven or eight in each whorl. In addition to these setae, the seta-like sensillae are present at the proximal end of each of the basal eight podomeres of the flagellum.

The first podomere of the flagellum is globular in the female, but tapers and increase slightly in length distally. The terminal podomere is provided with a nipple-like process at the end. The surfaces of these five podomeres are not covered with spines, but bear a number of setae and sensillae.

The first podomere of the flagellum is globular in the female, but tapers posteriorly to fit into the better-developed funnel-shaped depression of the pedicle. The 3rd, 4th and 5th podomeres are fused to each other at their proximal edges, while the remainder of the podomeres are connected by distinct membranes. The podomeres of the flagellum in the male gradually and noticeably decrease in size till towards the 8th podomere ; and then again increase in size towards the tip. The first podomere of the flagellum carries two incomplete whorls of moderately long setae. The following seven podomeres carry complete whorls of very long setae (fig. 34, 2nd podomere), but these whorls are interrupted, however, on the sides of the podomeres

that are covered with spines (fig. 34, 6th podomere of the flagellum). Two curved setae-like sensillae are found near the anterior end of these podomeres as in the female. The 9th and 10th podomeres are provided with few comparatively short setae, while the terminal three podomeres are more-or-less similar to those of the female.



Atrichopogon (Kempia) pavidus (Winn.)

Fig. 44: Longitudinal section through the middle part of the head of female. — Fig. 45: Transverse section through the second podomere of the labellum. — Fig. 46 : Transverse section through the first podomera of the labellum. — Fig. 47 : Transverse section through the middle of the mouth-parts. — Fig. 48 : Transverse section through the posterior part of the mouth-parts. — Figs. 49-50 : Transverse sections through the anterior part of the clypeal region.

(C) The mouth-parts

The labrum

The labrum in *A. pavidus* is more or less triangular in shape, and pointed at the tip. There is little difference between that of the female and that of the male, except that fewer bristles are present at the tip of the labrum in the latter (figs. 35 and 36).

As in *Culicoides impunctatus*, the labrum consists of four parts, a median, 2 lateral and a posterior part best seen in transverse sections (figs. 47 and 48). The median part is narrow (fig. 35) and its posterior end is produced into a very long process — the posterior process of the labrum — which extends inside the head capsule below the clypeal region (figs. 49-52). The elevator muscles of the labrum in *A. pavidus*, all arise on the clypeal region (the frontal region being extensively membraneous) and are inserted in the

posterior process of the labrum (fig. 44). The two lateral parts are attached to the median part by a membrane which widens posteriorly. In transverse sections (figs. 49 and 50), the lateral parts are seen to be fused with the anterior part of the clypeal region. The posterior part of the labrum lies ventrally to the median part, and in between the lateral parts (fig. 48). It carries four small rounded sensillae on the middle line (fig. 35)

The median, lateral, and posterior parts of the labrum, all unite at the anterior end forming one sclerotised pointed end (fig. 45).

The mandibles

The mandible of the female *A. pavidus* is in the form of an elongated blade which is wide in the middle, but narrows gradually towards the anterior end. The posterior end is curved outwards to articulate with the mandibular arm (fig. 37). The mandible carries at the anterior end of its inner edge about 15 small blunt teeth.

A dark spot is found in the middle of the blade of the mandible, corresponding to that present in *Culicoides*, but the spindle-shaped depression associated with this spot is incomplete in *A. pavidus*, being only represented by its inner border (fig. 37). By the study of the transverse sections of this region (fig. 47), it was found that the depression in the middle of the mandibles is not symmetrical, but slopes from right to left in the left (upper) mandible; and from left to right in the right (lower) mandible. It was also found that the process of the left mandible lies to the right of its corresponding depression, thus fitting into the depression of the right mandible. The process of the latter lies to the left of its corresponding depression, but close to the lumen of the salivary duct of the hypopharynx.

The curved posterior end of the mandible articulates with its mandibular arm through two processes similar to those described for *Culicoides*.

A small rod-like sclerite is associated with the mandible in *A. pavidus*, which is found, in transverse section (fig. 50) lying between the base of the mandible and the latter parts of the labrum. This structure is not found in the other Ceratopogonidae examined, and is also absent in the males of this species. No muscles are attached to this structure. Three tendons arise at the posterior end of the mandible similar in position and in function to those described in case of *Culicoides*.

The mandible of the male (fig. 38) is of nearly the same size as that of the female. The inner edge is straight and lacks teeth. The dark spot and the dark line present on the female mandible are here absent.

The maxilla

In both sexes, the cardo and stipes of one side have united with the corresponding parts of the other side. In the female, the cardo is in the

form of a single square plate, which is surrounded, except on the posterior side, by a thickened edge (fig. 39). The basal parts of the cardo are typically associated with the posterior tentorial pits (fig. 32). The fused stipites form a median plate limited by the continuation of the thickened edge of the cardo and which carry the laciniae, and two narrow lateral parts which carry the maxillary palpi. The lacinia is comparatively short and is not toothed at its anterior end. It is produced posteriorly into a long process comparable to the posterior process of the lacinia in *Culicoides*. In transverse sections the lacinia is found to have a mebraneous dorsal wall and sclerotised ventral wall (figs. 47 and 48). The maxillary palp consists of five podomeres, the third of which is the largest and carries a deep pit which opens towards its inner dilated edge. This pit is homologous with the sense organ present on the 3rd podomere of the maxillary palp in *C. impunctatus*.

The maxilla of the male is about the same size as that of the female. The cardo and stipes are similar to those of the male *C. impunctatus*. The lacinia is similar to that of the female, but it carries a group of thin bristles at its anterior end. The maxillary palp is similar to that of the female.

The labium

The labium in *A. pavidus* consists of the prementum and two labella each consisting of 2 podomeres, the postmentum and the ligula being absent (fig. 41). The prementum is somewhat narrower anteriorly than posteriorly. Its ventral surface bears 4 moderately long setae on each side, and is partly covered with small spines. Seen in transverse sections (fig. 48) the prementum has a dorsal membraneous wall which is deeply concave to serve for the reception of the other mouth-parts. The ventral wall is sclerotised, and is produced in the middle line into a heavily sclerotised internal carina which divides the prementum internally into 2 incomplete compartments. This ridge or carina extends backwards and bifurcates near the posterior end of the prementum (figs. 41 and 52).

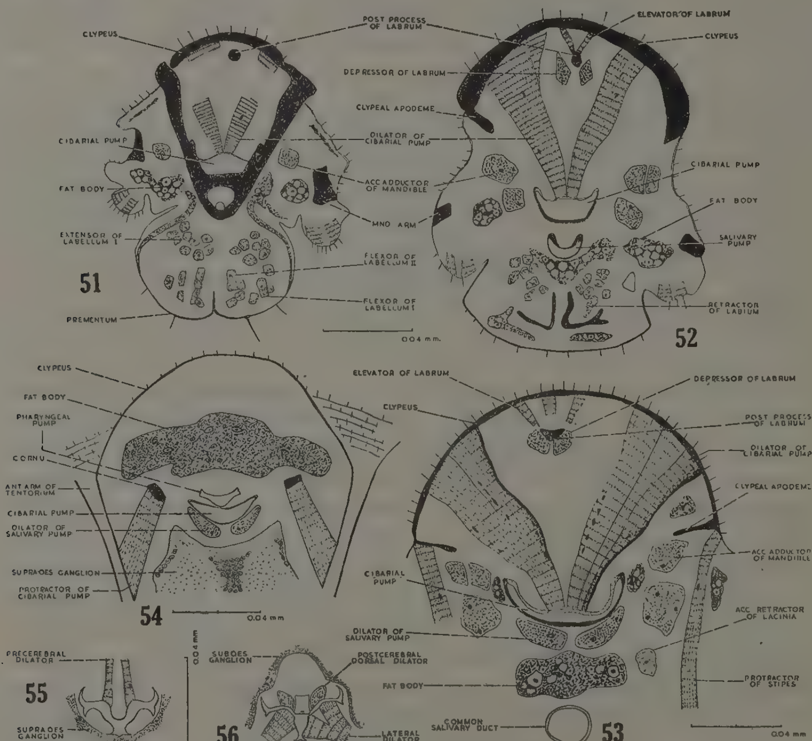
The first podomere of the labellum is attached to the prementum by a membrane lying at its anterior end. It is about equal in length to the prementum, and its anterior half is free. The ventral ridge of the prementum extends anteriorly and dorsally on the first podomere of the labellum and bifurcates again in the free anterior part (figs. 41 and 46).

The second podomere of the labellum is small and is attached to the first by a membrane. In transverse sections, it is seen to be in the form of two lobes which enclose the tips of the labrum, mandibles and hypopharynx. Their inner membraneous walls possess rows of small bristles directed forwards.

The ventral surfaces of both podomeres of the labellum are provided wiht a number of moderately long setae and a few scattered spines. The

second podomeres carry, on their inner walls, five pairs of gustatory sensillae similar to those present in *Culicoides*.

The labium is provided with the same muscles as those described in *Culicoides*, viz. retractor of labium flexors and extensors of the 1st podomere of the labellum and flexors of the second podomere of the labellum (figs 44 and 49).



Atrichopogon (Kempia) pavidus (Winn.)

Figs. 51-52: Transverse sections through the anterior part of the clypeal region. — Fig. 53: Transverse section through the middle of the clypeal region. — Fig. 54 : Transverse section through the posterior part of the clypeal region. — Fig. 55 : Transverse section through the anterior part of the pharyngeal pump. — Fig. 56 : Transverse section through the posterior part of the pharyngeal pump.

The labium of the male is about the same size as that of the female, and consists of the same parts.

(D) The hypopharynx and the sucking apparatus

The hypopharynx in *A. pavidus* is in the form of a triangular blade

with its base adjacent to the anterior end of the cibarial pump, and its apex tapering to a point (fig. 42). The hypopharynx is not armed wih either teeth or spines. Its posterior third is perforated by the salivary duct which is continued anteriorly as a groove opening on the dorsal surface of the organ and ending near the anterior end. In transverse section (figs. 47 and 48) the hypopharynx is seen to lie ventrally to the right mandible and dorsally to the labium. The blade of the hypopharynx is straight at its anterior end, but it becomes V-shaped posteriorly (fig. 49) and its sclerotised parts fuse with the lateral parts of the labrum (fig. 51).

The hypopharynx, in the male, is of about the same length, and is similar in structure to that of the female.

The cibarial pump is built on the same plan as that in *Culicoides*. Seen in transverse sections it is U-shaped having a dorsal membraneous wall to which the dilator muscles are inserted. Its ventral and lateral walls are sclerotised (fig. 53). At its posterior end its lateral walls are produced into two strong processes, the cornua, which serve for the attachment of the retractor and protractor muscles (figs. 44 and 54). The cornua project dorsally in the case of the female and laterally in the case of the male (figs. 42 and 43) resembling *Culicoides* in this respect.

The phrayngeal pump is somewhat less developed than that of *Culicoides*, but it consists essentially of the same parts. It is similarly provided with pre- and post-cerebral dorsal dilator muscles and posterior lateral dilators.

The salivary pump is also similar in construction to that of *Culicoides*. Seen in transverse sections (fig. 52) it is crescent shaped lying ventral to the cibarial pump to which its dilator muscles are attached (figs. 44 and 53).

From the description given above regarding the mouth-parts, especially those concerning the tips of the labrum, mandibles, maxillae and hypopharynx, all of which being weakly sclerotized and lack functional teeth, it is evident that *A. pavidus* cannot be « predaceous » and must be considered as nectar feeder.

V. THE HEAD-CAPSULE AND MOUTH-PARTS IN DICROBEZZIA VENUSTA MG.

(A) The head-capsule

Dicrobezzia venusta Mg. belongs to a third type of Ceratopogonid which are usually referred to as « predaceous ».

The clypeal region occupies most of the area anterior to the antennae (fig. 57). It is in the form of one large plate bounded laterally by the edges of the compound eyes. Anteriorly the clypeal region is connected with the labrum through a pair of inverted small Y-shaped sclerites, the tormae

(fig. 62). In the male, the clypeal region is surrounded laterally by a membrane and the setae carried on this sclerite are less numerous than those in the female.

The frontal region is fused to the clypeal region anteriorly. It consists of a very narrow band lying in between the antennal sockets, together with those parts which lie anterior to the vertex, on either side of the posterior part of the narrow band. This latter part is situated between two sutures which take their origin from the anterior tentorial pits, and are curved posteriorly through an obtuse angle to join near to the junction of the compound eyes in the female, and, in the male to a point slightly more anterior. The ocelli are carried on the frontal region just below the ridge connecting the compound eyes at the top of the head.

The vertex is bounded anteriorly by the V-shaped ridge between the compound eyes. It is narrower in the case of the male and bears more anteriorly directed setae.

The posterior parts of the head-capsule are formed by the occiput and postgena (fig. 59). There is, however, no membraneous area separating the postgenae from the basal parts of the maxilla.

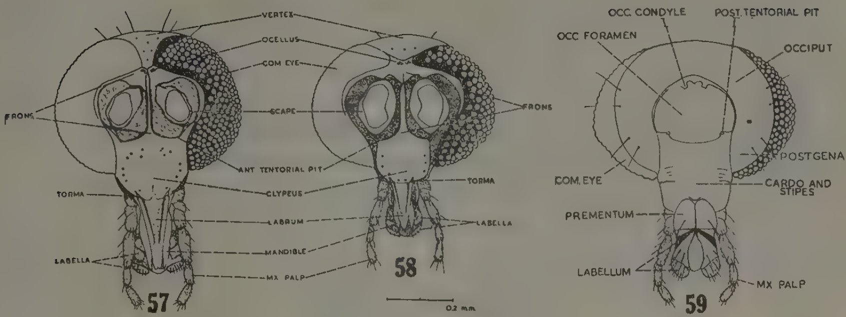
(B) The antenna

The scape (fig 57) is ring shaped, strongly sclerotised and has a prominent process on its posterior border. This podomere is much bigger in the male than in the female (fig. 58).

The pedicle (fig. 60) is globular, dark brown in colour and possesses a deep depression at its anterior end which serves for the reception of the first podomere of the flagellum. The surface of the pedicle is covered with minute spines and carries a few setae which are directed forwards.

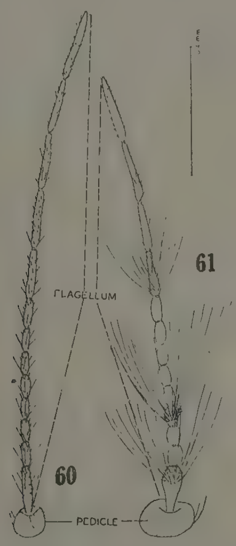
The flagellum consists of 13 podomeres, the terminal five of which exceed in length the basal eight (fig. 60). The first podomere of the flagellum is elongated and its basal end fits into the depreession of the pedicle. The podomeres 2-8 are more or less equal in size. They carry a number of moderately long setae arranged in whorls, together with a number of scattered seta-like sensillae. The terminal elongated podomeres bear few shorter setae not arranged in whorls.

In the male, the first podomere of the flagellum is wide anteriorly and tapers posteriorly to fit into the funnel-shaped depression of the pedicle. The following eight podomeres are of about the same length, but much wider than the corresponding podomeres of the female. The 4 terminal podomeres of the flagellum are elongated, and slightly broader basally. The setae of the basal 10 podomeres are very long and arranged in whorls. The terminal three podomeres only bear few setae similar to those of the female.



Dicrobezzia venusta Mg.

Fig. 57 : Head of female, front view. — Fig. 58 : Head of male, front view. — Fig. 59: Head of female, posterior view.



Dicrobezzia venusta Mg.

Fig. 60 : Antenna of female. — Fig. 61 : Antenna of male.

(C) The mouth-parts

The labrum

The median part of the labrum is convex and heavily sclerotised. Its posterior end articulates with the Y-shaped torma, and is produced into a long process, the posterior process of the labrum (fig. 62). Anteriorly the median part fuses with the other parts (fig. 71) and at the tip is provided with a pair of hook-shaped teeth. The lateral parts are serrated on their

distal two-thirds. Posteriorly their external edges fuse with the tormae. They are separated from the median part by a membrane (figs. 62 and 74). The posterior part of the labrum is concave and almost membraneous. It occupies a median position ventral to the median part and in between the lateral parts (figs. 72-74). At the anterior third of the epipharyngeal part, lie two small sensillae, one slightly anterior to the other (fig. 62).

The labrum of the male (fig. 63) is shorter than that of the female. It carries a small number of bristles at its anterior end, while its lateral parts are serrated on their anterior third only.

The mandibles

The mandible in the female (fig. 65) is very large and provided with teeth on its inner and outer margins of its anterior end. It is narrow anteriorly and widens in its middle part while its thick base is curved outwards. The teeth on the inner margin of the mandible are very well developed and sharp, the majority of them are directed backwards while the few anterior teeth are directed forwards. On the outer margin of the manible six small teeth are present which are all directed forwards. The spindle, and the structures associated with it, are very prominent in the mandible of female *Dicrobezzia venusta* (fig. 73). Posteriorly, the mandible carries its usual tendons arising in the same way as those of *Culicoides* and *Atrichopogon*.

The mandible of the male (fig. 64) is one third shorter than that of the female. The teeth on its anterior end are reduced and irregular. The ovoid spot is present in the middle of the mandible but it is very small and lacks the spindle.

The maxilla

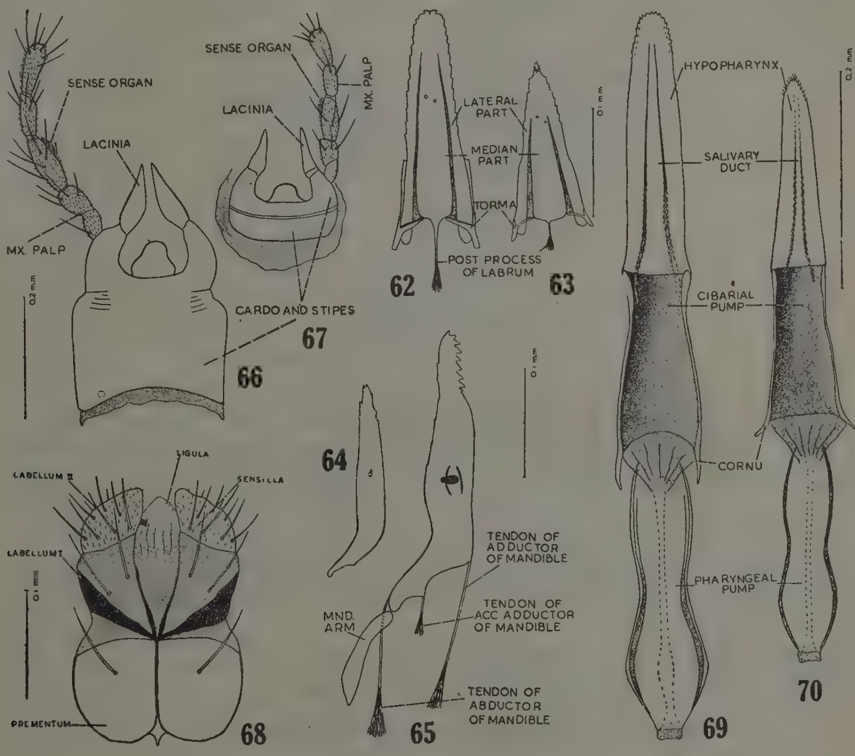
The maxilla in the female consists of cardo and stipes which are not separated by complete sutures, a short lacinia and a maxillary palp consisting of 5 podomeres (fig. 66). The cardo and stipes are in the form of a broad plate situated just below the occipital foramen and occupying the area between the postgenae (fig. 59). The associations of the posterior tentorial pits with the basal parts of the maxilla are retained. Anteriorly this plate carries two lateral and a median lobe. The lateral lobes carry the triangular laciniae which are sclerotised on their ventral sides, the dorsal surfaces being membraneous (figs. 73 and 74). The lacinae are short and in transverse sections they do not appear in the regions of the labella. The maxillary palp carries a number of knobbed hair-like sensillae on the inner side of the third podomere.

In the male there is a definite ridge separating the components of the basal parts of the maxillae (fig. 67). The relation of the posterior tentorial pits to the basal sclerite (stipes) is lost in the male owing to the reduction

of this sclerite and the existence of a wide membrane between it and the occipital foramen. Other parts of the male maxilla do not differ (except in size) from their corresponding parts of the female.

The labium

The labium in *Dicrobezzia venusta* consists of prementum and labella (fig. 68). The width of the prementum exceeds its length and is cleft deeply

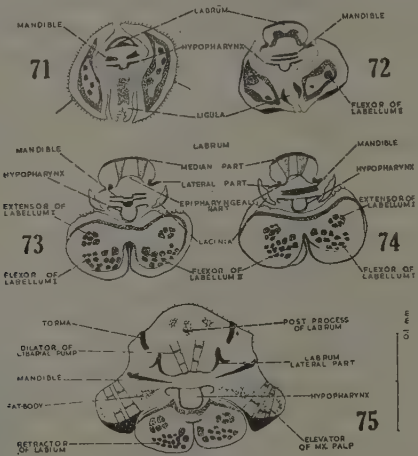


Dicrobezzia venusta Mg.

Fig. 62 : Labrum of female. — Fig. 63 : Labrum of male. — Fig. 64 : Mandible of male. — Fig. 65 : Mandible of female. — Fig. 66 : Maxilla of female. — Fig. 67 : Maxilla of male. — Fig. 68 : Labium of female. — Fig. 69 : Hypopharynx and sucking apparatus of the female. — Fig. 70 : Hypopharynx and sucking apparatus of the male.

ventrally (fig. 74). The internal ridge of the prementum extends posteriorly as a short spine but it does not bifurcate as in *Atrichopogon*. The ventral surface of the prementum is devoid of spines and carries only two long setae at the anterior end.

The first podomeres of the labella are attached to the prementum by wide membraneous areas. The basal parts of each podomere are sclerotised while the remainder of the podomeres remain membraneous and carry four long setae. The second podomeres of the labella are short and provided



Dicrobezzia venusta Mg.

Fig. 71 : Transverse section through the second podomere of the labellum. — Fig. 72 : Transverse section through the first podomere of the labellum. — Fig. 73 : Transverse section through the middle of the mouth-parts. — Fig. 74 : Transverse section through the posterior region of the mouth-parts. — Fig. 75 : Transverse section through the base of the mouth-parts.

with small spines and carry numerous long setae and ten sensillae. The wide space existing between the podomeres of the labella is occupied by the large membraneous ligula (fig. 68) which is thrown into many folds near the anterior end.

The labium of the male, apart from being shorter than that of the female, is very similar to the latter in all details.

(D) The hypopharynx and the sucking apparatus

The hypopharynx in the female (fig. 69) is a tongue-like structure armed with numerous small sharp teeth at its tip and along the anterior parts of its lateral margins. In transverse sections (figs. 73, 74, and 75) in the middle and posterior parts of the hypopharynx it is seen that its edges curve ventrally and are connected by means of a membrane which surrounds the salivary duct.

The hypopharynx of the male (fig. 70) is one-third shorter than that of the female and its tip is provided with only a few short bristles. The sucking apparatus is built on the same plan as in *Culicoides* and *Dicrobezzia*. It is better developed in the female than in the male.

VI. COMPARATIVE MORPHOLOGY OF THE HEAD AND THE MOUTH-PARTS IN THE CERATOPOGONIDAE

All biting midges were previously included in one genus, *Ceratopogon*, belonging to the family Chironomidae. Malloch (1917) was the first to recognise the group as a separate family, the Ceratopogonidae, and the large genus was eventually dismembered. Several attempts have been made by many workers to set out the means for the determination of the genera, the latest of which was that put forward by Macfie (1940) and is mainly based on characters of the wings and legs. According to this scheme, the British midges can be divided into the following groups :

(A) *Forcipomyia*-group, which includes the following genera : (1) *Atrichopogon*, (2) *Lasiohelea*, (3) *Forcipomyia*, and (4) *Apelma*.

(B) *Dasyhelea*-group, including (5) *Dasyhelea*.

(C) *Culicoides*-group, including (6) *Culicoides*.

(D) *Ceratopogon*-group, which includes (7) *Ceratopogon*, and (8) *Isohelea*.

(E) *Stilobezzia*-group, including the genera (9) *Stilobezzia*, (10) *Serromyia*, and (11) *Monohelea* (*Schizohelea*).

(F) *Palpomyia*-group, including (12) *Clinohelea*, (13) *Neurohelea*, (14) *Palpomyia*, and (15) *Johannsenomyia*.

(G) *Bezzia*-group, including (16) *Bezzia*, and (17) *Dicrobezzia*.

In the previous chapters, the head capsule and the mouth parts of representatives from the groups A, C and G (having different feeding habits) were studied in detail. To cover the rest of the family the head-capsule and mouth-parts were also studied in the following genera :

Forcipomyia, belonging to group A ; *Stilobezzia* and *Schizohelea*, belonging to group E ; and *Palpomyia*, belonging to group F.

Moreover, species of the following genera were also examined for the mouth-parts only :

Dasyhelea, belonging to group B ; *Ceratopogon* and *Isohelea*, belonging to group D ; *Serromyia* belonging to group E ; *Neurohelea* and *Johannsenomyia*, belonging to group F ; and *Bezzia*, belonging to group G.

(A) The head-capsule

The clypeal region

This is the largest region of the head-capsule occupying the mesal area between the labrum and the bases of the antennae. It is usually surrounded laterally by membraneous areas, except in a few cases, e.g. *Palpomyia* (fig. 78) and *Dicrobezzia* (fig. 57), where the clypeal region is almost completely sclerotised. In *Culicoides* (fig. 1) and *Schizohelea* (fig. 76) it is divided externally into a median and two lateral parts. In the other genera it is in the form of a single plate, though the division may be internal by

the clypeal apodemes as in *Atrichopogon* (fig. 53). The clypeal region always carries a number of long setae which vary in number and in arrangement in the different genera and in the different species of the same genus.

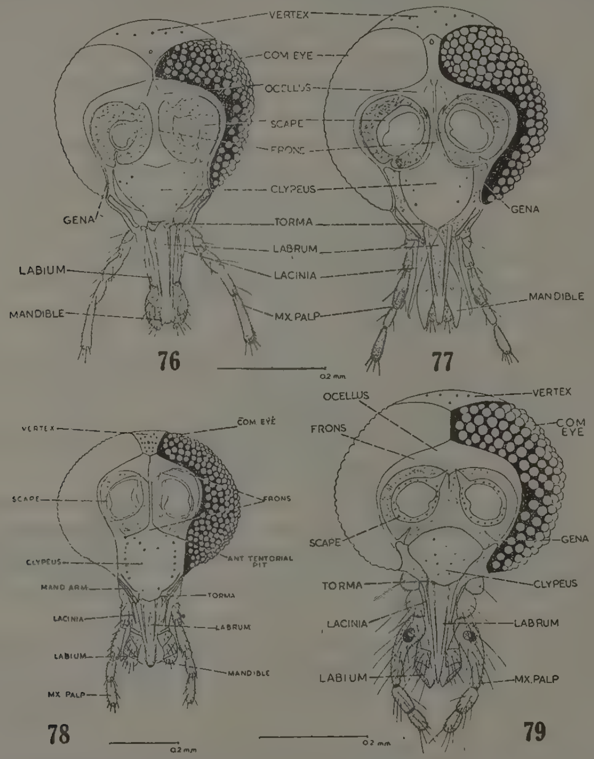


Fig. 76 : Front view of head of *Schizohelea leucopezia* (Mg.). — Fig. 77 : Front view of head of *Stilobezzia ochracea* (Winn.). — Fig. 78 : Front view of head of female *Palpomyia luteifemorata* (Edw.). — Fig. 79 : Front view of head of female *Forcipomyia* spec.

It is evident that the extensive development of the clypeal region in the Ceratopogonidae is related to the fact that the well developed dilators of the cibarial pump always take their origin on this part of the head-capsule.

The torma

With the exception of *Atrichopogon* (*Kempia*) a torma is usually present in the Ceratopogonidae joining the labrum to the clypeal region. In *Culicoides* (fig. 6) it is a simple sclerotised piece while in *Schizohelea*, *Stilobezzia*, *Palpomyia* and *Forcipomyia* (figs. 76-79) it is Y-shaped similar to that described in *Dicrobezzia*.

The frontal region

In all the Ceratopogonidae, the frontal region is reduced. It comprises the parts of the head-capsule in between and around the antennal sockets. The part lying in between the two antennal sockets may be entirely membraneous as in *Atrichopogon* (fig. 31) and *Forcipomyia* (fig. 79). The part lying towards the junction of the two compound eyes usually carries ridges which project inside the head as apodemes which serve for the attachment of muscles.

The vertex

The vertex varies greatly in width and in outline in the different genera and in the different species of the same genus, and in the different sexes of the same species. This is the result of the variations of the relative position of the two compound eyes at the top of the head-capsule.

The vertex is supplied with long setae which are directed forwards. The chaetotaxy of the vertex may be useful in the identification of the Ceratopogonidae as it seems to vary from one species to the other.

The compound eyes

The borders of the compound eyes may be approximated to each other towards the top of the head as in *Atrichopogon* (*Kempia*) and *Forcipomyia*; but more frequently they are separated by a part of the vertex, e.g. *Culicoides*, *Dicrobezzia*, *Schizohelea*, *Stilobezzia* and *Palpomyia*.

The facets of the compound eyes are usually rounded, with the exception of *Stilobezzia* when they are hexagonal (fig. 77). The compound eyes in the Certapogonidae are usually bare but in some genera, e.g. *Atrichopogon* (*Kempia*) and *Dasyhelea* they are pubescent and this character is of great systematic importance in the identification of the genera.

Other parts of the head-capsule are much more similar to each other, throughout the family.

(B) The antenna

The antenna in the Ceratopogonidae consists of 15 podomeres : scape, pedicle and 13 podomered flagellum. The scape (figs. 76-79) is always ring-shaped with a distinct process at the posterior border. It is usually much larger in the male than in the female. The pedicle (figs. 80-83) is globular and its anterior end is invaginated to receive the first podomere of the flagellum which is generally more elongated than the following seven podomeres. These podomeres (2nd-8th) of the flagellum resemble each other and they may be globular, e.g. *Schizohelea* (fig. 80) and *Atrichopogon* (fig. 33), flask-shaped, e.g. *Forcipomyia* (fig. 81), oval, e.g. *Culicoides* (fig. 4), or elongated, e.g. *Dicrobezzia* (fig. 60), *Stilobezzia* (fig. 82) and *Palpomyia* (fig. 83). Usually, these podomeres bear whorls of setae, which

are longer than the length of the podomeres, and one or two seta-like sensillae. In *Forcipomyia*, these sensillae are thick and very prominent. The five terminal podomeres are always different in character from the others, and this seems to be a constant character of the family. In *Dicrobezzia*, *Palpomyia* and *Stilobezzia*, they are longer than the podomeres of the re-

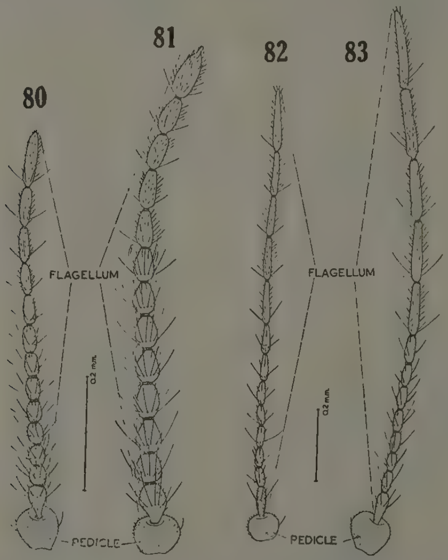


Fig. 80 : Antenna of female *Schizohelea leucopezia* (Mg.). — Fig. 81 : Antenna of female *Forcipomyia* spec. — Fig. 82 : Antenna of female *Stilobezzia ochracea* (Winn.). — Fig. 83 : Antenna of female *Palpomyia luteifemorata* (Edw.).

mainder of the antennae. In the other genera they are more elongated than the preceeding podomeres. In all caess the setae borne on these podomeres are not in whorls and they are usually shorter than the length of the podomeres.

(C) The mouth-parts

The labrum

The labrum in the Ceratopogonidae is composed of four parts, a median part, two lateral parts and a posterior part. In this respect it agrees with all other blood-sucking Nematocera.

The median part of the labrum is joined to the lateral parts by a membrane which, in some genera, e.g. *Stilobezzia* (fig. 85) and *Atrichopogon* (fig. 35), invades the posterior end. The median part of the labrum is usually produced posteriorly into a long apodemous rod-like structure — the

posterior process of the labrum, which serves for the attachment of the labral muscles.

Sensillae are always present near the anterior end of the posterior part of the labrum and appear in whole mounts as transparent spots. They are usually two in number (3 in *Culicoides*) placed on a horizontal line, e.g. *Schizohelea* (fig. 84), or on a vertical line, e.g. *Stilobezzia* (fig. 85), or obliquely, e.g. *Dicrobezzia*, *Palpomyia* and *Forcipomyia* (figs. 62, 86, 87).

The study of the anatomy of the labrum, as a piercing organ, shows that it could belong to one of the following three types :

(1) The *Forcipomyia*-type, where the anterior end is entirely devoid of teeth and either bare or with few bristles, e.g. *Atrichopogon* (fig. 35) and *Forcipomyia* (fig. 87).

(2) The *Culicoides*-type (fig. 7), where the anterior end is provided with comparatively small sharp teeth.

(3) The *Dicrobezzia*-type, where the tip is supplied with prominent teeth and hooks and the anterior margins of the lateral parts of the labrum are serrated, e.g. *Dicrobezzia* (fig. 62), *Stilobezzia* (fig. 85), and *Palpomyia* (fig. 86).

This division is in accordance with the known feeding habits of these insects. The second group sucks blood from mammals and hence it is supplied with a toothed piercing organ. The feeding habits of the first group are not known precisely, but it is evident from their anatomy that they are not adapted for piercing, and since they are found on flowers (as mentioned already in case of *Atrichopogon pavidus*), it is more likely that the group are nectar-feeders. The third group is often described as « predaceous ». In the following chapter, it will be shown that this term is rather inaccurate and that this group is also blood-sucking but on other insects. The labrum in this group resembles that of the first group in being toothed, but differs in having the teeth more numerous and stronger, and in the organ being more sclerotised. This, of course, is attributed to the nature of the hard exoskeleton of the victims.

The mandibles

Mandibles are absent in both sexes of *Dasyhelea dufouri* (Laboullene) and probably in all other species of this genus. They are present in both sexes of all other genera. In *Forcipomyia* (fig. 91), the mandible is reduced, lightly sclerotised and devoid of teeth. Mandibular arms are lacking in this genus and in *Dasyhelea* (as well as in the males of all the genera in the family). In all other genera, other than *Forcipomyia* and *Dasyhelea*, the mandibles in the female are well developed and toothed, and are attached to the head-capsule by means of mandibular arms.

Teeth are present on both edges of the anterior part of the mandible in *Dicrobezzia* (fig. 65), *Palpomyia* (fig. 90), *Ceratopogon* (fig. 92), *Serromyia* (fig. 94), *Neurohelea* (fig. 95), *Johannensenomyia* (fig. 96), and *Bezzia* (fig. 97). They are present on the inner edge only in *Culicoides* (fig. 9), *Atrichopogon* (fig. 37), *Schizohelea* (fig. 88), *Stilobezzia* (fig. 89), and *Isohelea* (fig. 93). Teeth present on the inner edges of the mandibles are usually directed backwards while those present on the outer edge are usually small and directed forwards. The number of teeth on the inneer edges of the mandibles, varies from one insect to another. It is 19 in *Bezzia* (fig. 97) and 7 in *Palpomyia* (fig. 90) as representing the two extremes. The number of the outer teeth is usually smaller. The number of teeth on the mandible seems to be constant for the same species; but may vary among the different species of the same genus. In *Culicoides* and *Atrichpogon*, the teeth are all more-or-less equal in size, while, in most of the other genera, those at the anterior end are better developed than those which lie posteriorly.

The spindle and mandibular process are lacking in *Forcipomyia* (fig. 91). They are present in all other generea, with the exception of *Schizohelea* (fig. 88) and *Isohelea* (fig. 93), where a spindle only exists.

The mandibles, like the labrum, may be similarly classified as follows :

(1) The *Forcipomyia*-type which is entirely devoid of teeth. *Dasyhelea* which lacks mandibles altogether, may be included in this group.

(2) The *Culicoides*-type which is supplied with minute teeth.

(3) The *Dicrobezzia*-type which has numerous very well developed teeth.

The mandibles in the second group are adapted for piercing soft mammalian skin, those in the third group for piercing the hard exoskeleton of other insects. It is to be noticed that *Forcipomyia* spec. whose mandibles are devoid of teeth (fig. 91), belong to a group of unknown feeding habits, in contrast to another group in the genus *Forcipomyia* which are known to feed on caterpillars and possess toothed mandibles (Edwards 1923). It is probable that the first group of *Forcipomyia* are nectar-feeders.

The mandibles of *Atrichopogon pavidus* (fig. 37) presents some difficulty as they have rather more in common with the *Culicoides*-type than with the *Forcipomyia*-type. But when the other mouth-parts are taken into consideration, i.e. simple untoothed labrum, lacinia and hypopharynx, it will be evident that, in all probability, *Atrichopogon pavidus* is a nectar-feeder.

The movement performed by the mandibles seems to be only in association with the labrum and hypopharynx, since the mandibles of *Culicoides* remained locked together during the act of piercing (described in page 36) and there is no reason to believe that the mandibles in the other genera behave otherwise.

The maxilla

A maxilla having a maxillary blade (lacinia) is always present in both sexes in the Ceratopogonidae. The basal parts of the maxilla, the cardo and the stipes, vary considerably in shape throughout the family and, with the exception of female *Culicoides*, they fuse with the corresponding parts of the other side. The fusion of these parts to form a single sclerotised plate on the posterior surface of the head, ventral to the occipital foramen, is described in other Nematocera, namely, *Rhabdophaga*, *Bibiocephala* and *Chironomus* by Peterson (1916). In all cases there is a close constant association of the cephalic articulation of these basal parts of the maxilla, with the posterior tentorial pits.

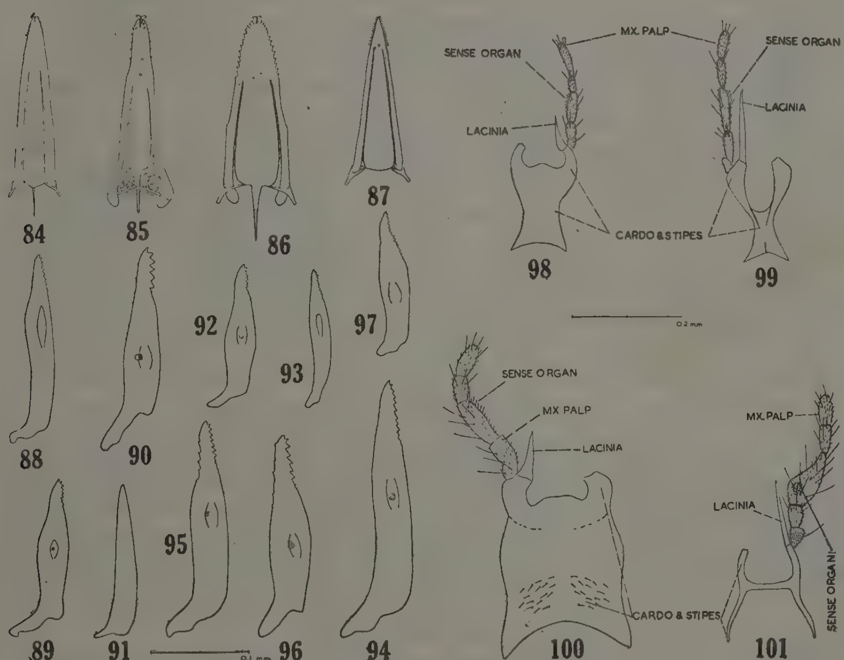


Fig. 84 : Labrum of female *Schizohelea leucopezia* (Mg.). — Fig. 85 : Labrum of female *Stilobezzia ochracea* (Winn.). — Fig. 86 : Labrum of female *Palpomyia luteifemorata* (Edw.). — Fig. 87 : Labrum of female *Forcipomyia* spec. — Fig. 88 : Mandible of female *Schizohelea leucopezia* (Mg.). — Fig. 89 : Mandible of female *Stilobezzia ochracea* (Winn.). — Fig. 90 : Mandible of female *Palpomyia luteifemorata* (Edw.). — Fig. 91 : Mandible of female *Forcipomyia* spec. — Fig. 92 : Mandible of female *Ceratopogon* spec. — Fig. 93 : Mandible of female *Isohelea* spec. — Fig. 94 : Mandible of female *Serromyia femorata* (Mg.). — Fig. 95 : Mandible of female *Neurohelea luteitarsis* (Mg.). — Fig. 96 : Mandible of female *Johannensenomyia nitida* (Mcq.). — Fig. 97 : Mandible of female *Bezzia ornata* (Mg.). — Fig. 98 : Maxilla of female *Schizohelea leucopezia* (Mg.). — Fig. 99 : Maxilla of female *Stilobezzia ochracea* (Winn.). — Fig. 100 : Maxilla of female *Palpomyia luteifemorata* (Edw.). — Fig. 101 : Maxilla of female *Forcipomyia* spec.

There are two extreme cases regarding the disposition of the cardo and stipes into the wall of the head-capsule in the Ceratopogonidae. In one case, those of one side are separated from the corresponding parts of the other side by an extensive membraneous area, e.g. *Culicoides* (fig. 3). In the other extreme, the cardo and stipes of the two sides fuse together forming one sclerotised plate, leaving no membraneous area at all between these parts and the postgenae, e.g. *Dicrobezzia* (fig. 59) and *Palpomyia* (fig. 100). There is some evidence which indicates the way through which this transformation might have taken place. If the cardo and stipes of *Palpomyia* are compared with those of *Schizohelea* (fig. 98), it will be found that the only difference lies in the replacement of part of the sclerotised plate at the sides by a membrane. If now the corresponding parts of *Stilobezzia* (fig. 99) are compared with those of *Schizohelea*, it will be evident that the reduction of sclerotised parts and its replacement by membrane has gone further, especially in the middle part. In *Forcipomyia* (fig. 101), a further invasion of membrane takes place, affecting the distal and proximal parts of the cardo and stipes, leaving only a barrow transverse bar joining the two sides. The case of *Culicoides* (fig. 3) can now be compared ot that of *Forcipomyia*, the main difference being the absence of the transverse bar in the *Culicoides*.

The lacinia in the Ceratopogonidae is usually weakly sclerotised on its ventral surface only. With the exception of *Culicoides*, it is short and not toothed at its anterior end but tapers to a point. The structure of the lacinia, in genera other than *Culicoides*, shows that it is not a piercing organ and that its function is probably taken over by the mandibles.

The maxillary palp always consists of five podomeres, the first or basal one is usually the smallest, while the third is the longest. This third podomere is often unilaterally dilated, e.g. *Culicoides* (fig. 12), *Atrichopogon* (fig. 39), *Forcipomyia* (fig. 101), and always carries, on the side of the podomeres facing the lacinia, a sense organ in the form of capitate hairs, e.g. *Culicoides*, *Dicrobezzia*, *Schizohelea*, *Stilobezzia* and *Palpomyia*, or a rounded pit, e.g. *Atrichopogon* and *Forcipomyia*.

Sense organs similar to those present on the maxillary palpi of the Ceratopogonidae are also found in other families of the Nematocera. They are present in some Blepharoceridae, general in the Simuliidae, Bibionidae, Anisopodidae and Mycetophilidae. On the other hand, it appears to be lacking in the Dixidae, Culicidae, Psychodidae, Tipulidae, Trichoceridae and Cecidomyidae. The significance of this organ is not yet understood but it seems to have definite phylogenetic importance as it occurs also in some members of the Mecoptera, the order which is considered now as the nearest living representatives of ancestors of the Diptera.

The labium

The labium in the Ceratopogonidae consists of prementum and two-podomered labial palpi. A postmentum exists only in *Culicoides* as a simple sclerotised rod. The prementum is always grooved along the middle line

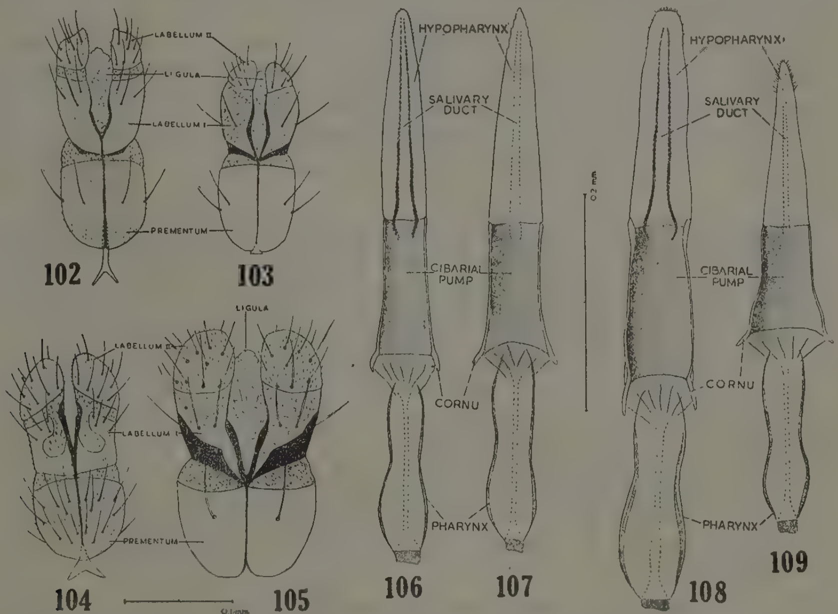


Fig. 102 : Labium of female *Schizohelea leucopezia* (Mg.). — Fig. 103 : Labium of female *Stilobezzia ochracea* (Mg.). — Fig. 104 : Labium of female *Forcipomyia* spec. — Fig. 105 : Labium of female *Palpomyia luteifemorata* (Edw.). — Fig. 106 : Hypopharynx and sucking apparatus of female *Schizohelea leucopezia* (Mg.). — Fig. 107 : Hypopharynx and sucking apparatus of female *Stilobezzia ochracea* (Mg.). — Fig. 108 : Hypopharynx and sucking apparatus of female *Palpomyia luteifemorata* (Edw.). — Fig. 109 : Hypopharynx and sucking apparatus of female *Forcipomyia* spec.

of its ventral surface. Internally, this groove corresponds to a ridge or carina which may extend beyond the posterior end of the prementum as in *Atrichopogon* (fig. 41), *Schizohelea* (fig. 102), *Stilobezzia* (fig. 103) and *Forcipomyia* (fig. 104), usually bifurcating posteriorly. The prementum bears long setae, the number and distribution of which varies in the different genera. The surface of the prementum may be covered with small spines, e.g. *Culicoides* (fig. 16), *Schizohelea* (fig. 102), *Forcipomyia* (fig. 104) and partly in *Atrichopogon* (fig. 41), or it may be quite devoid of such spines as in *Dicrobezzia* (fg. 68), *Stilobezzia* (fig. 103) and *Palpomyia* (fig. 105).

The first podomere of the labellum, which is attached to the prementum by a membrane, differs considerably, as to the amount of sclerotization of its wall, in the different representatives of the Ceratopogonidae. In *Dicrobezzia*, *Stilobezzia* and *Palpomyia*, most of the ventral surface of this podomere is membraneous, the sclerotized parts being only limited to the posterior ends. In most of the other genera, the membraneous areas are confined between the two podomeres of the labellum. The surface of the first podomere of the labellum, whether membraneous or sclerotised, bears a number of long setae, which again, varies in the different genera.

The second podomere of the labellum is more-or-less similar in all the genera. It carries several long setae and is generally supplied with gustatory sensillae.

A median lobe or ligula exists in the space between the podomeres of the labella in the genera *Culicoides* (fig. 16), *Dicrobezzia* (fig. 68), *Schizohelea* (fig. 102), *Stilobezzia* (fig. 103), and *Palpomyia* (fig. 105). It is absent in *Atrichopogon* (fig. 41) and *Forcipomyia* (fig. 104). It is interesting to notice that all other blood-sucking Nematocera possess a ligula, e.g. *Culex*, *Anopheles*, *Phlebotomus* and *Simulium*. Its presence, however, would not necessarily indicate a blood-sucking habit, as it is also found in non-blood-sucking flies, e.g. *Dixa* and *Rhyphus*.

The structure of the labium in the Ceratopogonidae shows that it is not adapted for piercing and its role in the piercing mechanism of *Culicoides*, already described, would apply to all other members of the group.

(D) The hypopharynx and the sucking apparatus

The hypopharynx in the Ceratopogonidae is in the form of a sclerotised blade, usually of the same length and width as the labrum, and arising from the floor of the cibarial pump. The hypopharynx does not vary greatly in the different representatives of the family except for the number, arrangement and length of the teeth or bristles carried on its tip. In *Culicoides* (fig. 17), *Atrichopogon* (fig. 42) and *Forcipomyia* (fig. 109), they bear resemblances to the labrum. In the other genera they are less developed than the labrum, e.g. *Schizohelea* (fig. 106), *Stilobezzia* (fig. 107) and *Palpomyia* (fig. 108).

The function of the hypopharynx, other than being a lesser piercing stylet, is the conveyance of salivia by means of the salivary duct, and although the hypopharynx is not provided with muscles, it may have movements of retraction and protraction effected by the retractor and protractor muscles of the cibarial pump (Krafchick, 1942).

A cibarial pump lying in the clypeal region of the head and a pharyngeal pump lying in the back part of the head are always present in the Cerato-

pogonidae. Their structure is similar throughout the family, varying only in size and in the direction of the cornua. In the blood-sucking genera of the Ceratopogonidae, the sucking apparatus is more developed in the females than in the males, while in the nectar-feeding representatives there is hardly any difference between the sucking apparatus of the two sexes.

(E) Discussion

It has been shown that, taking the structure of the mouth-parts (especially the labrum and the mandibles), the Ceratopogonidae can be divided into three groups : (1) the nectar-feeding group, (2) the vertebrate blood-sucking group, and (3) the insect blood-sucking (so-called « predaceous » group).

The examples studied in the previous Chapters may give support to Macfie's classification of the family (page 51), since the groups A and B are the nectar-feeding groups, group C, the vertebrate blood-sucking group and the rest (D, E, F and G) are all insect blood-sucking groups.

Thus the characters of the mouth-parts fit in, broadly, with the other characters of the systematic classification.

A difficulty arises, however, by the presence of blood-sucking cases among members of the first group (A). Thus, two species of *Atrichopogon* are known to suck blood from some coleopterous insects, and certain species of *Forcipomyia* and *Lasiohelea* attack other insects. (Details of these cases are dealt with in the following Chapter).

Unfortunately, material of these insects was not available, but according to a hint by Edwards (1923), a *Forcipomyia* attacking caterpillars was described as having toothed mandibles. As to the other insects, viz. *Atrichopogon* and *Lasiohelea*, nothing was mentioned regarding their mouth-parts, but it can be assumed that they have similar adaptations.

Therefore it can be argued that, although a tendency for blood-sucking exists among some species of the first group, the mouth-parts in general afford additional criteria which fits in and supports Macfie's systematic grouping of the Ceratopogonidae.

VII. FEEDING HABITS OF THE CERATOPOGONIDAE

Feeding habits among the Ceratopogonidae have attracted the attention of entomologists for a considerable time. Several isolated cases of feeding habits were placed on record by Fearnside (1900), Baker (1907), Gravely (1911), Stanton (1912), Kryger (1914), Edwards (1920, 1925, and 1932), and Varley (1948). Some attempts were made to review the literature on the subject by Knab (1914), Peyerimhoff (1917), and more recently by Edwards (1923) and Macfie (1932), most of these authors adding new observations of their own.

But up to the present, the literature of the feeding habits of this group, has been fragmentary and dispersed.

The object of this Chapter is to give a general review of the known feeding habits of the group and to incorporate some original observations.

Among the Ceratopogonidae, the known feeding habits can be classified into two main groups:

(1) Plant and nectar feeding, and (2) animal feeding.

Plant and nectar feeding

Two genera of the Ceratopogonidae are commonly found on flowers, viz. *Atrichopogon* and *Schizohelea*. *A.* (*Kempia*) *pavidus* Winn., *A. orbicularis* K. and *A. minutus* Mg., have been found present in both sexes, on honey-suckle and *Iris* flowers in Scotland (Luss). This is perhaps the only genus of the Ceratopogonidae where both sexes have been found in more-or-less equal numbers on flowers. It has been shown from anatomical evidence that *A.* (*Kempia*) *pavidus* is very probably, a nectar feeder rather than « predaceous » on small insects that might visit the same flowers.

The females only of *Schizohelea leucopezia* Mg. were found on Umbelliferae in the same region, but the structure of their mouth-parts indicates that they might be blood-sucking as well.

Some females of *Culicoides obsoletus* Mg. were found on leaves and trunks of trees lapping drops of sap. There seems to be some indication that not only a blood meal, but also some carbohydrate elements, are necessary for the production of a fertile batch of eggs in *Culicoides*.

Knab (1914) reports two females of *Forcipomyia erucicida* on flowers of an avocado (*Persea* spec.).

Two females of *Pterobosca paludis* were reported by Edwards (1937) feeding on flowers of *Heracleum* in company with several other species of Ceratopogonidae, including males of two species of *Forcipomyia*.

Lasiohelea japonica is claimed to feed on the nectar of flowers of Umbelliferae in Japan (Tokunaga, 1937). Both sexes are found together and the females are believed to be non blood-sucking.

Macfie (1944), who described some Ceratopogonidae collected in Trinidad by Posnette, from Cacao flowers, mentioned that the collector thought that some of the insects were of importance in the pollination of those flowers. Most of the insects were referable to two species, viz. *Forcipomyia quasi-ingrami* Macfie and *Lasiohelea nana* Macfie. Others collected from moss or cacao trunks were identified as *Atrichopogon brevipalis*, *Dasyhelea* spec., and *Stilobezzia* spec.

It is to be noticed that most of the above mentioned species belong to the first group in Macfie's classification (which was shown to be the

nectar-feeding group). The occurence of *Culicoides*, *Schizohelea* and *Stilobezzia* on flowers does not contradict their blood-sucking habit since they may be seeking extra nourishment (*Culicoides*) or may be hiding to attack other insects (*Schizohelea*).

Animal feeding

The majority of the Ceratopogonidae belong to this group regarding feeding habits. Insects and mammals are the common animals to suffer attacks by midges. Amphibia and Reptilia have never been reported to be attacked by midges at all while very few cases exist of Ceratopogonidae attacking birds, notably that reported by Tokunaga (1937) of *Ceratopogon arakawae* being most injurious to chickens in Japan, and that of Edwards (1939) stating that the American species, *Culicoides liguttatus* Coq., has been found in large numbers, gorged with blood, in the nests of crows and magpies.

Certapogonidae attacking vertebrate animals are clearly distinguished as blood-sucking insects. Those attacking insects were considered by Edwards (1923) as predaceous if they attack insects of approximately their own size or not much larger and kill them by puncturing their « skin » and sucking them dry, and blood-sucking if the attacking midge sucks the juices of the victim without as a rule, killing it, the victim in such cases being much larger than the midge.

This division into blood-sucking and predaceous habits does not seem natural for the following reasons :

(1) Edwards includes cases of midges attacking caterpillars as cases of blood-sucking. According to Baker (1907), however, caterpillars of the geometroid moths were attacked by midges which sucked them dry and left them « dead or dying ». The death of the victims in these cases, is not in accord with Edwards' interpretation of the blood-sucking midges. A similar case was reported by Edwards himself (1920) where a *Palpomyia* attacked a much larger Mayfly (*Bates* spec.) and sucked it dry through one of the victim's eyes.

(2) The distinction between predaceous and blood-sucking midges on the criterion of the size of the prey can not be regarded as definite or decisive, as those animals described as « much larger » than the midge, include all sizes varying from moths and caterpillars to birds and mammals. Size is evident when referring to a mammalian host but it is not so evident if the victim is a mosquito.

Therefore there is no ground for the distinction between predaceous midges and blood-sucking midges neither on account of the size nor of the survival of the prey.

It is proposed here, that both types shall be included in one group, the blood-sucking midges, and subdividing this group according to the type of the victim. It may be added that in all cases of « predaceous » midges they were always observed sucking the blood or other fluids from the prey and never devouring any other tissues.

Blood-sucking midges could be broadly divided into those attacking mammals and those attacking other insects. (Reference has already been made to the few cases of midges attacking birds).

(a) Midges attacking mammals

Domestic animals and man are the only mammals known to be subjected to the attacks of midges. Edwards (1939) mentions that in the Dartmoor area *C. heliophilus* Edw. may be seen flying in swarms round the heads of sheep.

Specimens of *C. parroti* Kieff. were taken feeding on a donkey, while *C. nubeculosus* Mg. is reported to attack horses, chiefly on the under side of the body. According to « The Second Report on Control of Midges » (Dept. of Health of Scotland, 1948), three species of *Culicoides*, viz. *C. grisescens* Edw., *C. impunctatus* Goet. and *C. fascipennis* Staeg. were found on cattle in Inverness-shire, and (on cattle, too) *C. impunctatus* Goet. was found in the Trossachs, and *C. obsoletus* Mg. and *C. pulicaris* L. at Luss. The species *C. heliophilus* Edw. was obtained on sheep in Peebles and in large numbers on a dog in Perthshire. The numbers of *C. grisescens* Edw. on cows were considerable; on one occasion more than 100 were found on a single cow, and the animals were sometimes enveloped by a grey cloud of midges numbering many thousands.

Since all these species of *Culicoides* are known to suck blood from man, it could be suggested that domestic animals may serve as an alternative host in areas rarely visited by man.

Most of the British species of *Culicoides* have been convicted of sucking human blood, the exceptions being *parroti* Kieff., *chiopterus* Mg., *circumscriptus* Kieff., *pictipennis* Staeg., and *pumilus* Winn. All of them are comparatively scarce and hence probably the lack of evidence agaist them.

The most annoying species of *Culicoides* in Britain are *impunctatus* Goet. in the north, and *obsoletus* Mg. in the south. Other significant species are *C. heliophilus* Edw., *C. pulicaris* L., *C. vexans* Staeg., and *C. nubeculosus* Mg.

Usually the « biting » of these midges occurs in the early morning and the late afternoon. Two species, however, feed in bright sunshine. Steward reports that *C. nubeculosus* Mg. feeds in the largest numbers between 10.30 a.m. and 1 p.m., but also in smaller numbers at any time of the day. *C. heliophilus* Edw. is also reported to be most active during

the middle of the day, « biting » freely in hot sun and disappearing before dusk. *C. vexans* Staeg. is known to enter houses to « bite », a feature very rare among other *Culicoides*.

All the above mentioned cases are concerned with the females. The structure of the mouth-parts of the male *Culicoides*, as described earlier, shows that they are not adapted for piercing. Probably they are nectar-feeders since their mouth-parts have more in common with the mouth-parts of this group.

(b) Midges attacking insects

Insects which have been reported to be attacked by midges belong to the orders : Orthoptera, Ephemeroptera, Odonata, Neuroptera, Lepidoptera, Coleoptera, and Diptera.

Orthoptera

There is a case mentioned by Williston (1908) of a minute fly which was found in the West Indies « closely applied to, and apparently sucking the juices from, the antenna of a Phasmid ». Although Williston considered the specimen to represent a Simulid fly, Edwards (1923) concludes from the figures given by Williston, that it is more probably a Ceratopogonid midge. According to Macfie (1932), it may belong to the genus *Forcipomyia*. Macfie also refers to two similar cases of *Forcipomyia* preying on phasmids which were found in South America. It seemed to him that *Forcipomyia ixodoides* Fiebrig-Gertz (1928) and *Forcipomyia obesa* da Costa Lima (1928) might be the same and it is possible that they are identical with Williston's species. Mayer (1937) created the new genus *Phasmidohelea* comprising 3 species : *crudelis* Mayer and the former two species, all being parasitic on Phasmids.

Ephemeroptera

Two cases of Ceratopogonidae — belonging to the genus *Palpomyia* — attacking Mayflies are on record, one by Edwards (1920) and the other by Varley (1948). In the former case *Palpomyia flavipes* Mg. was observed to settle on the back of the Mayfly *Baetis* spec. (which was much larger than itself) in the air, and to insert its proboscis into one of the Mafly's eyes and suck it dry. In the latter case Varley found *Palpomyia semifumosa* Goet. feeding on the thorax of the Mayfly *Rhithrogena semicolorata* Curtis.

Odonata

Ceratopogonidae are common on the wings of dragonflies in different parts of the world. The following list gives the names of the midges, their hosts, and countries, as reported by Macfie (1932 and 1936).

Pterobosca latipes Macfie, on *Potamarcha obscura* (Ramb.), in China; *Pterobosca fidens* Macfie, on *Orthetrum pruinosum neglectum* Ramb., in Hainan Island; *Pterobosca aerobates* Macfie, on *Idiomyx intricata* Fraser, in Assam; *Pterobosca aeschnosuga* (de Meij.), on *Procordula artemis* Lieft., on *Orthetrum pruinosum* Burm., and on *Zygonyx ida* Selys, in Java; *Pterobosca adhesipes* Macfie, on *Agrionoptera insignis altogenes* Tillyard, on *Hemicordulia silvorum* Ris, on *Orthetrum sabina* Drury, and on *Lestes praemorsus* Selys, in New-Guinea; *Pterobosca adhesipes* Macfie, on *Orthetrum chrysis* Selys, and on *Raphismia bispina* Hagen, in Java Sea; *Pterobosca mollipes* Macfie, on *Trithemis arteriosa*, in Liberia; *Pterobosca odonatiphila* Macfie, on *gynacantha kirbyi* Kruger, and on *Gynacantha mocsaryi* Foerster, in New-Guinea; *Pterobosca ariel* Macfie, on *Orthetrum sabina* Drury, in the Moluccas; *Lasiohelea samoensis* Edw., on *Orthetrum signiferum* Lieft., and on *Orthetrum villosovittatum* Brauer, in the Moluccas; *Lasiohelea samoensis* Edw., on *Natoneura salomonsis* Selys, in New-Guinea; *Lasiohelea pemambula* Macfie, on *Orthetrum signiferum* Lieft., in the Moluccas; and *Lasiohelea intrepida* Macfie, on *Erythrodiplax erratica* Erichson, in the Peru.

In Britain (Wicken Fen), two midges were caught on wings of *Coenagrion pulchellum* Lind. and *Lestes sponsa* Kirby, and were named *Pterobosca paludis*, the genus having been discovered for the first time in Europe (Macfie 1936). Later, several specimens of the same insect were found in the same locality on other hosts, mainly on *Enallagma cyathigerum* and *Ischnura elegans*, and to a less extent on the larger dragonflies *Libellula quadrimaculata* and *Brachytron pratense*. Edwards, who reported these cases (1937), mentions that « usually not more than 5-10 % of the dragonflies captured were found infested and each infested host rarely carried more than one or two parasites; some specimens of *Enallagma cyathigerum*, however, carried as many as five flies ».

According to Macfie, some of these midges cling to the wing of their host by means of the empodium as claws are absent and in these cases the empodium is peculiarly adapted for clinging to a flat surface.

Neuroptera

Very few cases are known of midges attacking Neuroptera.

A midge recorded on Neuroptera is *Forcipomyia eques* (Johannsen). This was found by Edwards (1932) on wings of *Chrysopa flavifrons* and *C. perla*. *Forcipomyia eques* was first described by Johannsen in 1908, from specimen taken on wings of a lace-wing *Meleoma* in New-York State. It is said to be fairly common on the wings of several species of Chrysopidae in North America. It was also found on wing of *Chrysopa perla* in Finland. Another species of *Forcipomyia*, viz. *F. fusicornis* Coq., was observed

attacking a Sialid (*Chauliodes* spec.), by Malloch in 1915, but he did not state which part of the Sialid was attacked.

Lepidoptera

Midges were recorded on wings and bodies of adult moths and butterflies in Britain and Switzerland by Edwards (1923 and 1925). In all cases the midges belong to *Forcipomyia* (*Euforcipomyia*) *papilionivora* Edw., first found in North Wales on the wing of a « Cabbage White » butterfly (*Pieries rapae* L.). In Switzerland, it was found attacking the moths *Ectropis crepuscularis*, *Boarmia repandata* and *Porthetria monacha*. Earlier, Knab (1914) reported a similar attack of a midge on the wing of a geometrid moth (*Cidaria didymata* L.) in Denmark. The midge was not precisely identified at the time, but according to Edwards (1923) it is probable that it is identical with *F. papilionivora*.

Several cases are on record of midges sucking the juices of caterpillars, and it is interesting to note that all the midges belong to one genus, viz. *Forcipomyia*. The earliest of these records was made by Baker (1907) when he described an attack of midges on the larvae of *Melanchroia geometroides* (Walker) in Cuba. The midges, from one to six on each larva, were found sucking the caterpillars and leaving their blackened skin hanging from the twigs. The midge, according to Knab (1914), was *Forcipomyia propinquus* (Will.). Knab also reviewed all previous records of midges sucking juices of caterpillars which can be listed as follows :

Forcipomyia squamosa Lutz, on Sphingid caterpillars, in Peru and Brazil ; *Forcipomyia crudelis* Knab, on Sphingid caterpillars, in Mexico : and *Forcipomyia erucicida* Knab, on larva of the papaya sphinx *Erinnyis ello* (L.), in Florida.

Other cases are quoted by Edwards (1923) and Macfie (1932), and include *F. hirtipes* (de Meij.) found sucking a larva of *Papilio clytia* and a larva of *Othreis fullonica* in Ceylon and Samoa, and *F. alboclavata* (Kieff.) which was recorded « sitting on the back of larvae of *Deilephila galii* in Hungary ».

Coleoptera

Three cases are on records of midges attacking Coleoptera. The victims in all cases belong to one genus, viz. *Meloe*. The first was noticed in Algeria, by Peyerimhoff (1917), where midges, which were later determined by Edwards as *Atrichopogon meloesugans*, were obserbed sucking the blood of the beetle *Meloe majalis* L. Peyerimhoff mentioned that « the midges pursue these large beetles in little swarms and without inconveniencing them in any way, feed upon their yellow blood ». The second case is reported by Hansen (1921), from Denmark. The beetle was *Meloe proscarabaeus* and the midges were, again, identified by Edwards

as *Atrichopogon rostratus* Winn. According to Hansen « little swarms of gnats hovered over the beetle and attacked it, especially on the soft skin between the first and second thoracic segments and on the under side ». In this case, however, the beetle was seriously affected and tried in vain to get rid of its tormentors.

The third of these cases comes from England (Devon) and reported by Blair (1937). The midge, which was identified by Edwards as *Atrichopogon meloesugans*, was found on the back, as well as on the under side of *Meloe proscarabaeus* and *M. violaceous*, sucking at the intersegmental membrane or other softer membranes at the sides of the dorsal shields. Other specimens of the same midge were seen crawling on the grass, their bodies distended with the yellow blood of the *Meloe*.

Diptera

Representatives of four families (Tipulidae, Culicidae, Chironomidae, and Ceratopogonidae) of the Diptera, all belonging to the Nematocera, are reported to be attacked by midges.

Midges attacking Tipulidae

Two cases are reported of midges attacking Tipulidae, one by Edwards (1933) from North Borneo, and the other by Macfie (1936) from Dutch New-Guinea. The midge in the first case was identified by Edwards as *Lasiohelea equitans* and was found attacking *Trentepohlia pennipes* O.S. In the second case, Macfie identified the midge as *Forcipomyia* (*Lasiohelea*) *tipulivora* on the thorax of a *Tipula* spec.

In the collection of the British Museum there is another example of a *Lasiohelea* spec. on a Tipulid taken in Nigeria. The proboscis of the fly was found inserted into the thorax of a specimen of *Ceratocheilus longirostris* Wesche.

Midges attacking Culicidae

A species of *Culicoides* is known to obtain engorged blood from the abdomen of its mosquito host. Gravely (1911) found, in India, a specimen of *Culicoides* firmly attached by the proboscis to the abdomen of a mosquito. Knab (1914) cites similar cases found by O'Gorman Lalor of *Culicoides* attacking *Anopheles*, and by Fearnside and Stanton of *Culicoides* feeding on the undersurface of the abdomen of *Culex* and *Anopheles*.

These cases are of special interest since it could be argued that *Culicoides* originally used to feed on juices of other insects, e.g. Chironomids, then it passed to a diet of Mosquito blood and thence to the mammalian blood inside the body of the latter. It may be easily imagined then that the *Culicoides* traced the mosquito host to its feeding grounds and eventually

took to sucking blood directly from the mammal thus leading to the widely-known habit of sucking blood among many species of the genus *Culicoides*. This view is supported, according to Edwards (1923), by the fact that *Culicoides anophelis* Edwards (1922) shows some morphological primitive features.

On the other hand it might be claimed that *Culicoides* was essentially mammalian blood-sucking and that it has only taken the mammalian blood « second-hand from the mosquito » (Gravely, 1911). This latter view seems more probable as it was shown by Lamborn that a blood meal was essential to the production of fertile eggs.

Midges attacking Chironomidae

Most of the work done in this field has been by Edwards (1920 and 1923) and may be summarised in the following list :

Stilobezzia gracilis (Hal.), on *Cricotopus pulchripes* Verr., on *Orthocladius* spec., on *Tanytarsus* (two species), and on *Tanypus binotatus*; *Serromyia femorata* F., on *Cricotopus pulchripes* Verr., and on *Trichocladius* spec. ; *Psilohelea candidata* Winn., on *Trichocladius* spec. ; *Isohelea lacteipennis* Zett., on *Camptocladius ? gracilis* Goet. ; *Palpomyia ? nigripes*, on *Tanypus guttipennis* Wulp ; and *Bezzia annulipes* Mg., on *Tanytarsus sylvaticus* Wulp.

Midges attacking Ceratopogonidae (*other midges*)

The females of *Serromyia femorata F.* and *Johannsenomyia nitida* Maq. are believed to suck the juices and blood of their own males. Edwards (1920) noticed that during pairing in *Serromyia femorata* « the female carried the male beneath her, the ventral surfaces of the two insects being in contact and the mouth-parts joined. After some time in this position the female devours her partner apparently sucking him dry through the mouth ». The same process seems likely to occur in *Johannsenomyia nitida* as many females of this species were found having the genital organs of the male attached to their abdomens.

There is also another case of this type in which *Isohelea lacteipennis* was reported preying on its own male (Edwards, 1920).

Some of the larger midges prey on smaller members of other genera. Edwards (1920) reports that *Serromyia femorata* F. attacks *Bezzia ornata* Mg., *Isohelea lacteipennis* Zett. attacks *Culicoides impunctatus*, and *Probezzia ? signata* Mg. attacks *Culicoides pulicaris*.

The writer here reports for the first time a case of *Serromyia femorata* attacking *Isohelea sociabilis* Goet. and the same insect also attacking *Culicoides impunctatus*. Both were captured in Seil Island (Argyllshire, Scotland) by Mr. J.A. Downes.

Moreover, there is on record a case of *Forcipomyia erudelis* (Karsch 1886) sucking a saw-fly larva in Germany, and a case of *F. peregrina* (Joh.) feeding on a dead worm in North America, and reported by Malloch 1915.

There is no difficulty in correlating the structure of the mouth-parts with the feeding habits of these insect blood-sucking midges since the majority of them belong to the 3rd group (D-G in Macfie's classification, page 51). This group is uniform in having strong toothed mandibles and labrum.

The few cases which belong to the 1st group (group A), e.g. *Forcipomyia* and *Lasiohelea*, can be explained as tendencies for blood-sucking within the nectar-feeding group. Thus, they may form a sort of intermediate link between the nectar-feeding group and the blood-sucking group.

VIII. MEDICAL IMPORTANCE OF THE CERATOPOGONIDAE

The role played by some *Culicoides*, in the spread of disease has been revealed comparatively very recently. Dyce-Sharp (1928) has found in Nigeria that *Filaria perstans* Manson undergoes metamorphosis in the body of *Culicoides austeni* Carter and probably also in *C. grahami* Austen. The young stage of this worm is common in the blood of man and higher apes in that region though not known to cause any pathological developments in man.

Buckley (1933-34) made experiments on specimens of *Culicoides furens* Poey, feeding them on blood of carriers of *Filaria ozzardi* Manson. He found that some of the midges were subsequently infected with the developing stages of the parasite. Moreover, he found that 5 % of *C. furens* caught at Calliqna (St. Vincent) were naturally infected with developing larvae of the same parasite.

In England (Herefordshire), Steward (1933) discovered that *C. nubeculosus* Mg. transmits the worm *Onchocerca cervicalis* Railliet and Henry to horses, causing them nuchal diseases (fistulous withers and « poll-evil »).

IX. SUMMARY

(1) The head-capsule and the mouth-parts of the blood-sucking *Culicoides impunctatus* are described in detail as the type for the Ceratopogonidae.

(2) Snodgrass' claim (1947) that the « sutures » of the head are merely cleavage lines of ecdysis is accepted with reservation.

(3) Robinson's view (1939) rejecting the dual conception and nomenclature of the « labrum epipharynx » is confirmed and the term « labrum » is used instead.

(4) The maxillary blade is shown on evidence of its muscles to be the lacinia and not the galea.

(5) The homologies of the labellum and the ligula are discussed in detail.

(6) The muscles and the mechanism of piercing are described.

(7) The head-capsule and the mouth-parts of two other representatives of the family having different types of feeding habits, viz. *Atrichopogon* (*Kempia*) *pavidus* and *Dicrobezzia venusta* are also studied in some detail.

(8) A comparative study of the head-capsule and the mouth-parts of a wider selection of the family is made and the correlation between the structure of the mouth-parts and their functions is established and related to the systematic classification based on Macfie's scheme (1940).

(9) A detailed review of the known feeding habits of the Ceratopogonidae is given at the end and again related to the structure of the mouth-parts.

X. ACKNOWLEDGMENTS

I am indebted to Professor A.J. Grove of Queen Mary College, London, who supervised this work during my study in England. His criticism and advice were indispensable for the carrying through of the research.

Thanks are due to Mr. B. Jobling of the Wellcome Research Laboratories for suggesting the problem and for guiding me to some recent references.

To Mr. J.A. Downes, I am indebted for the supply of many insects used in the present work and also for the facilities he offered me at Glasgow University and at the Field Station at Luss.

Thanks are also due to Dr. J.W.S. Macfie and Mr. P. Freeman of the British Museum (Natural History) for the identification of some of the insects.

XI. BIBLIOGRAPHY

Adler, S., and Theodor, O. (1926): The mouth parts, alimentary tract, and salivary apparatus of the female in *Phlebotomus papatasii* (*Ann. Trop. Med. Parasit.*, p. 109).

Baker, C.F. (1907) : Remarkable habits of an important predaceous fly (*Bull. United States Dept. Agric.*, Bur. Ent., No. 67, p. 117).

Blair, K.G. (1937) : Midges attacking *Meloe* beetles (*Ent. Mon. Mag.*, LXXIII, p. 143).

Brues, C.T. (1946) : Insect dietary (Cambridge, Massachusetts).

Buckley, J.J.C. (1933) : A note on the development of *Filaria ozzardi* in *Culicoides furens* Poey (*J. Helminth.*, XI, p. 257).

Buckley, J.J.C. (1934) : On the development in *Culicoides furens* Poey., of *Filaria* (*Mansonella*) *ozzardi* Manson, 1897 (*J. Helminth.*, XII, p. 99).

Carter, H.F., Ingram, A, and Macfie, J.W.S. (1920) : Observations on the Ceratopogonine midges of the Gold Coast with description of new species. Parts II and III (*Ann. Trop. Med. Parasit.*, XIV, pp. 211 and 309).

Christophers, S.R., Shortt, H.E., and Barraud, P.J. (1926) : The anatomy of the sandfly (*Phlebotomus argentipes* Ann. and Brun (Diptera). 1. The head and mouth-parts of the imago (*Ind. Med. Res. Mem.*, No. 4., p. 177).

Crampton, G.C. (1921) : The sclerites of the head, and the mouth-parts of certain immature and adult insects (*Ann. Ent. Soc. America*, XIV, p. 65).

Crampton, G.C. (1923) : A phylogenetic comparison of the maxillae through the orders of insects (*Journal New-York Ent. Soc.*, XXXI, p. 77).

Crampton, G.C. (1923) : A comparison of the labium in certain holometabolous insects from the standpoint of phylogeny (*Proc. Ent. Soc. Wash.*, XXV, p. 171).

Crampton, G.C. (1925) : A phylogenetic study of the labium of holometabolous insects, with particular reference to the Diptera (*Proc. Ent. Soc. Wash.*, XXVII, p. 68).

De Meillon, B. (1939) : Notes on Ceratopogonidae (Dipt. Nematocera) from S. Africa (*Journ. Ent. Soc. Southern Africa*, I, p. 9).

Du Porte, E.M. (1946) : Observations on the morphology of the face in insects (*Jour. Morph.*, LXXIX, p. 371).

Edwards, F.W. (1920) : Some records of predaceous Ceratopogoninae (*Ent. Mon. Mag.*, LVI, p. 203).

Edwards, F.W. (1922) : On some Malayan and other species of *Culicoides*, with a note on the genus *Lasiohelea* (*Bull. Ent. Res.*, XIII, pt. 2, August, pp. 161-167, 1 plate).

Edwards, F.W. (1923) : New and old observations on Ceratopogoninae midges attacking other insects (*Ann. Trop. Med. Parasit.*, XVII, p. 19).

Edwards, F.W. (1925) : A midge attacking moths in Swiss (*Ent. Mon. Mag.*, LVI, p. 228).

Edwards, F.W. (1926) : On the British biting midges (Diptera Ceratopogonidae) (*Trans. Ent. Soc., London*, LXXIV, p. 389).

Edwards, F.W. (1932) : A midge attacking Lace-wing flies in Britain (*Ent. Mon. Mag.*, LXVIII, p. 114).

Edwards, F.W. (1933) : Diptera Nematocera from Mount Kinabahr (*J.F.M.S.*, Mus., Kuala Lumpur, XVII, p. 251).

Edwards, F.W. Oldroyd, H., and Smart, J. (1939) : British blood-sucking flies (British Museum [Nat. Hist.], London, p. 25).

Fearnside, C.J. (1900) : Parasites found on mosquitoes (*Indian Med. Gazette*, XXXV, p. 129).

Frey, R. (1913) : Ueber die Mundteile der Mycetophiliden, Sciariden und Cecidomyiiden (*Acta Soc. Fauna Flora Fenn.*, XXXVII, No. 2).

Gravely, F.H. (1911) : Mosquito sucked by a midge (*Rec. Indian Mus.*, VI, p. 45).

Hansen, H.J. (1930) : Studies on Arthropoda, III. (Copenhagen glydendalske Boghandel).

Imms, A.D. (1944) : On the constitution of the maxilla and labium in Mecoptera and Diptera (*Quart. J. Micr. Sci.* [N.S.], LXXXV, p. 73).

Jobling, B. (1928) : The structure of the head and mouth-parts in *Culicoides pulicaris* L. (Diptera Nematocera) (*Bull. Ent. Res.*, XVIII, p. 211).

Johnston, C. (1855) : Auditory apparatus of the *Culex* Mosquito (*Journ. Micr. Sci.*, III, p. 97).

Karsh, F. (1886) : Ein neues markisches Dipteron (*Berl. ent. Zeit.*, XXX, sitzber. p. 17).

Kellogg, V.L. (1899) : The mouth-parts of the Nematocera, Diptera (*Psyche*, VIII, pp. 303, 327, 346, 355, and 363).

Kieffer, J.J. (1925) : Chironomides Ceratopogoninae (Diptères Nematocères piqueurs) (*Faune de France*, II, Paris).

Knab, F. (1914) : Ceratopogininae sucking the blood of caterpillars (*Proc. Ent. Soc. Wash.* XVI, p. 63).

Knab, F. (1914) : Ceratopogoninae sucking the blood of other insects (*Proc. Ent. Soc. Wash.*, XVI, p. 139).

Krafchick, B. (1942) : The mouth-parts of Blackflies, with special reference to *Eusimulium lascivum* Twinn. (*Ann. Ent. Soc. America*, XXXV, p. 426).

Kryger, J.P. (1914) : En Myg, der angriber en Sommerfugl (*Ent. Meddel.*, X (V), p. 83).

Leon, N. (1924) : L'armature buccale et la pompe salivaire des *Culicoides pulicaris* (*Bull. Sect. Sci. Acad. Roumaine*, IX, Nos. 1-2, p. 17).

Macfie, J.W.S. (1932) : Ceratopogonidae from the wings of dragonflies (*Tijdschr. v. Entom.*, LXXV, p. 265).

Macfie, J.W.S. (1936) : Two new species of Ceratopogonidae (Diptera) from the wings of Dragonflies (*Proc. R. Ent. Soc. London.*, V, p. 62).

Macfie, J.W.S. (1936) : Four species of Ceratopogonidae (Diptera) from the wings of insects (*Proc. R. Ent. Soc. London*, V, p. 227).

Macfie, J.W.S. (1937) : Notes on Ceratopogonidae (Diptera) (*Proc. R. Ent. Soc. London* (B), VI, p. 111).

Macfie, J.W.S. (1940) : The genera of Ceratopogonidae (*Ann. Trop. Med. Parasit.*, XXXIV, p. 13).

Macfie, J.W.S. (1945) : Ceratopogonidae collected in Trinidad from Cacao flowers (*Bull. Ent. Res.*, XXXV, p. 297).

Mac Gillivry, A.D. (1924) : Crampton : on the labium of certain Holometabola (*Proc. Ent. Soc. Wash.*, XXVI, No. 5, p. 133).

Malloch, J.R. (1915) : Some additional records of Chironomidae for Illinois (*Bull. Ill. State Lab. Nat. Hist.*, XI, p. 315).

Malloch, J.R. (1917) : A preliminary classification of Diptera, Part I (*Bull. Ill. State Lab. Nat. Hist.*, XII, p. 281).

Mayer, K. (1937) : Beobachtungen über blutsugende Ceratopogoniden (Diptera) (*Arb. morph. taxon. Ent.*, Berlin, IV, p. 231).

Otanes, F.Q. (1922) : Head and mouth-parts of Mecoptera (*Ann. Ent. Soc. America*, XV, p. 310).

Patton, W.S., and Craig, F.W. (1913) : A text-book of Medical Entomology (London, Madras, and Calcutta).

Patton, W.S., and Evans, A.M. (1929) : Insects, Ticks, Mites and Venomous Animals (School of Tropical Medicine, Liverpool).

Peterson, A. (1916) : The head-capsule and mouth-parts of Diptera (*Ill. Biol. Monogr.*, III, No. 2).

Peyerimhoff, P. de (1917) : *Ceratopogon* et *Meloe* (*Bull. Soc. ent. France*, p. 250).

Riley, W.A. (1904) : The embryological developments of the skeleton of the head of *Blatta* (*Amer. Nat.*, XXXVI, p. 777).

Robinson, G.G. (1939) : The mouth-parts and their functions in the female mosquito *Anopheles maculipennis* (*Parasitology*, London, XXXI, p. 212).

Sharp, N.A., and Dyce (1928) : *Filaria perstans* : its development in *Culicoides austeni* (*Trans. R. Soc. Trop. Med. Hyg.*, XXI, p. 371).

Snodgrass, R.E. (1935) : Principles of Insect Morphology (London and New-York).

Snodgrass, R.E. (1943) : The feeding apparatus of biting and disease-carrying flies (*Smith. Misc. Coll.*, CIV, No. 1).

Snodgrass, R.E. (1944) : The feeding apparatus of biting and sucking insects affecting man and animals (*Smith. Misc. Coll.*, CIV, No. 7).

Snodgrass, R.E. (1947) : The insect cranium and the « Epicranial suture ». (*Smith. Misc. Coll.*, CVII, No. 7).

Stainton, A.T. (1912) : A *Ceratopogon* parasitic upon anopheline mosquitoes (*Paludism*, No. 5, p. 64).

Steward, J.S. (1933) : *Onchocerca cervicalis* (Raillet and Henry 1910) and its development in *Culicoides nubeculosus* Mg. (Univ Camb. Inst. Anim. Path., III, p. 272).

Tillyard, R.J. (1926) : The insects of Australia and New Zealand (Sydney, Angus and Robertson Ltd.).

Tokunaga, M. ((1937) : Sand flies (Ceratopogonidae, Diptera) from Japan (*Tenthredo*, Koyoto, I, p. 233).

Varley, G.C. (1948) : A ceratopogonid fly, *Palpomyia semifumosa* Goet., feeding on Mayflies (*Ent. Mon. Mag.*, XXXIV, p. 36).

Vogel, R. (1920) : Kritische und erganzende Mitteilungen zur anatomie des Stechapparat der Culiciden und Tabaniden (*Zool. Jahrb.*, XLII, p. 259).

Weber, H. (1933) : Lehrbuch der Entomologie (Jena, G. Fischer).

Williston, S.W. (1908) : Manual of North American Diptera (New Haven).

Studies on the Biology and Control of *Epilachna chrysomelina* F., in Egypt

[Coleoptera - Coccinellidae]

(with 1 Plate, 18 Tables, and 3 Graphs)

by Dr. Abd El-Aziz Aly El-Sayed Ghabn
Senior Entomologist, Ministry of Agriculture, Cairo.

E.P.A.

CONTENTS

I. INTRODUCTION

Epilachna chrysomelina F. was once considered as a secondary pest in Egypt. In recent times the cultivation of cucurbitaceous crops has increased enormously, amounting to 80000 feddans during 1939. Although the area decreased during the last war, amounting to 56000 feddans in 1945, yet it rose again to 67561 feddans in 1950. It is undoubtedly expected that it will soon reach the level of 1939 and even more in consequence of the continuous increase of population and the advance of the general standard of living in Egypt.

Table I shows the distribution of cucurbitaceous crops in the different provinces of Egypt in 1950, according to the statistics of the Department of Agricultural Economics and Legislation of the Ministry of Agriculture in Egypt. It appears that Giza, to the south of Cairo, and Behera, to the south of Alexandria, are the main provinces in cultivating these crops, followed by Sharkia, Fayoum, Assiut, Menoufia, Beni-Suef, Gharbia, Minia and Girga. It also appears that the cultivations of these crops are denser near the big towns and similar places which are thickly populated or have big industries.

From the entomological point of view, the ecological factors of these main districts for cultivating cucurbitaceous plants are most favourable for the development and increase of *Epilachna*, especially in the northern provinces. This being the case, it was considered necessary to study in detail the pests of such developing crops.

TABLE I

Area of cucurbitaceous crops in feddans (acres)

PROVINCES	WATER-MELON	MELON	MARROW	CUCUMBER	TOTAL
Lower-Egypt					
Behera	4884	3287	4825	1778	13774
Gharbia	685	1139	435	100	2359
Fouadia	716	525	83	83	1407
Dakahlia	183	705	48	77	1013
Sharkia	5628	1322	1478	941	9369
Menoufia	1433	564	256	235	2488
Calioubia	2038	1389	1074	645	5246
Middle-Egypt					
Giza	5969	4530	3266	2467	16232
Beni-Suef	956	1174	171	99	2400
Fayoum	1978	445	275	397	3095
Minia	1483	638	198	33	2352
Upper-Egypt					
Assiut	1771	744	142	25	2682
Girga	1658	433	126	56	2273
Kena	845	243	111	61	1260
Aswan	339	24	92	3	458
Total Lower-Egypt	15567	8931	8452	3859	36809
Total Middle-Egypt	10386	6787	3910	2996	24079
Total Upper-Egypt	4613	1444	471	145	6673
TOTAL...	30566	17162	12833	7000	67561

With the exception of cotton leaf worm, *Prodenia litura* F., which occasionally attacks these plants seriously, *Epilachna*, the subject of this study, is considered the major pest of the cucurbitaceous crops in Egypt. The infestation differs according to different seasons and localities; in some years it is so severe that active control measures are advocated to save the crop. Water-melons (*Citrullus vulgaris*) appears to be the favourite host of *Epilachna*. The area planted with it represents about 45 % of the total area of cucurbitaceous crops, and its value is estimated at about three and a half millions Egyptian pounds. The next favoured host is melons (*Cucumis melo*) which cover about 25 % of the whole area; estimated at about two millions Egyptian pounds. This is followed by marrows (*Cucurbita pepo* var. *ovifera*) which cover about 19 % of the total area, estimated at about two millions Egyptian pounds. The least favoured host is cucumber (*Cucumis sativus*), which covers about

10.5 % of the total area, estimated at about half a million Egyptian pounds. The value of the whole cucurbitaceous plants cultivated in Egypt in 1950, thus amounted to about eight millions Egyptian pounds, according to the average present prices. Any neglect in immediate control, when *Epilachna* is threatening, may cause great loss in the total income of the country.

Experiments of control were carried out in the fields of the Ministry of Agriculture at Dokky and Barrage, while the studies of the life-history were completed in the laboratory of the Entomological Section, at Dokky.

II. MATERIAL AND TECHNIQUE OF BREEDING

About the middle of March collections of hibernating adults were gathered from their winter shelters. From these collections males were separated from females and groups of ten specimens of each were put in a petri-dish, 15 cms. in diameter and 3 cms. high, to acclimatise under laboratory conditions. After a fortnight, seven males and seven females were chosen and each of the 7 couples were separately put into a smaller petri-dish, 10 cms. in diameter and 2 cms. in height. The necessary food of melon leaves was added twice a day. In order to keep sufficient humidity, a small dish was put inside, half full with water, and water was added from time to time to keep it to the same level. To obtain food during winter time, melon plants were cultivated in ordinary pots, 20 cms. in diameter and 30 cms. high, filled with earth and watered every few days and kept in green houses temperated artificially at 20 to 22° C. through the whole winter season.

The material was examined daily and when oviposition started, leaves with eggs on were transferred to new petri-dishes, and fresh leaves were added. Daily examination continued, and all larvae which hatched the same day were collected from different dishes and put in groups of tens in new petri-dishes, with labels showing the date of hatching. All larvae which moulted on one day were put again in groups of tens in new petri-dishes and so on until the emergence of the adults. To every petri-dish there corresponded a numbered card in which all changes were recorded and reference given at the same time to the numbers of the other corresponding petri-dishes.

For studying the second generation, seven pairs of males and females were chosen from those emerged, on the first day, being considered as the biologically most active individuals. Each couple was put in a petri-dish as already mentioned for the first generation. In the same way, the study of the further successive generations was continued. As regards temperature, a daily reading was recorded in the laboratory and the average temperature of each instar was calculated in the usual way.

The main idea of putting the insects during their development in groups of tens, was to facilitate the daily observations and the comparison between

the number of moulting insects with their cast off skins. It was expected from the data gathered from the study in the laboratory, that the duration periods of the instars were slightly higher than they actually should be, as it was practically impossible to make more than one observation every twenty four hours.

III. MORPHOLOGY

The imago

(Plate, fig. 1)

The adult is fulvous. The females are a little bigger than the males; the integument is covered with fine hairs. The head is broad, round behind and at the edges as well. Genae : only a little arched. Frons : little impressed. Gula : little projected. The eyes, seen from above, appear only slightly kidney-shaped, in fact they are rather more elongate-oval, the kidney-shape of the eyes is little pronounced. The eyes themselves are so inserted on both sides of the head so that their dorsal part is larger than their ventral one. The antennae lie between the eyes and the base of the mandibles; they are composed of 11 segments; the first one is largest and nearly semi-circular in anterior part; the second much smaller and of a cylindrical shape; the third is also little prolonged and narrowed at the base; the following four joints are nearly of equal cylindrical form and size; the eighth segment is little broader than the foregoing ones; each of the 9th, 10th and 11th segments is nearly double as large as the 8th, and dark coloured; the last segment is conical; all segments have bristles; on the last three segments there are, besides the bristles, also small, dense, fixed sense organs. The clypeus has a narrow-straight form and has no hairs. The labrum is nearly twice as broad as long, little narrowed at the base and rounded at the edges; the anterior half of the labrum is lighter than the posterior half, and covered with hairs at the upper part; in the middle of the front margin one notices a weak depression; the posterior half of the labrum is dark brown, more densely furnished with hairs, has a greater number of longer bristles, and is conceivably arched in the middle. In the males, the bristles are more strongly developed than in the females. The mandibles are dark-brown and curved sickle-like; on the interior margin, many small, and 2-5 large teeth are seen, the last of which is found at the distal end of the mandibles and not in the same row with the proximal ones; the larger teeth are like very sharp triangles of nearly equal sides; between the large teeth there is a great number of smaller ones which are also found on the proximal part of the mandibles so that they are gradually joined on its dorsal part; small teeth are also found on the lower part of the larger first teeth of the mandibles; three of the stout teeth are set on one level, the first of which is the largest; altogether, there are about 25 small teeth. Differences in the form and size of the mandibular teeth were

noticed in beetles of different ages : in older ones, the teeth are more or less blunt and rounded, in younger specimens sharp and pointed ; on the base of the outer and inner side of the mandibles there are small bristles of which those found on the outer side are more strongly developed. At rest, the mandibles appear closed and entirely covered by the labrum. The maxillae are composed of five parts ; the lobus externus and lobus internus are furnished with long bristles, cardo, squama palpigera and stipes bear only single small bristles. The palpus maxillaris is composed of 4 segments, the last of which is longest ; the latter is axe-shaped and obliquely truncate at its distal end ; all segments of the palpus maxillaris, especially the last one, have many bristles. The labium is composed of six angular segments. Mentum with two palpi labiales and submentum. The palpi labiales are three-segmented and bear, as the other parts of the labium a few bristles ; such bristles are also found on the outer side of the submentum.

The prothorax is smooth, broad and convex ; the anterior portion has two large symmetrical projections which surround the head behind from both sides ; size and form of these projections and also the form of the basal part of the neck-shield are different individually. The mesothorax is light brown to reddish-brown. The metathorax is dark, the first sternites have dark stripes which run from the middle to the right and the left. Thorax and sternites are covered with small fine hairs. The metathorax of *Epilachna chrysomelina* F. is pointed in front. The elytra are furnished with very fine hairs ; each elytron bears six black spots, the size of which is variable. The rim of the spots appears serrate. The distribution of the spots on each elytron is as follows : 1 and 2 on the base, 3 and 4 in the middle (3 on the suture normally more in front) thus 4 on the lateral margin, 5 on the suture in two-thirds of the length, 6 on the outer margin, little before the tip. The elytra are sometimes black, their spots surrounded by a wide fulvous border (var. *costae* Ws.).

With regard to variation of colour, Klemm (10) described several varieties of which *costae* Ws. is the commonest one in Egypt. The wing is about 1.5 cm. long and 5-6 mms. broad, with 6 veins, of which the costa and subcosta are weak ; radius and media are strongly developed ; the cubitus is branched at base, but the branches unite distally.

In all three pairs of legs, the tibiae, tarsi, and claws are of nearly the same form. Femur, trochanter and coxa are distinguished in all three pairs by shape and size. The tarsus is composed of 4 segments of which the first is largest, the second dilated and spade-like at the end, the third is smallest and inconspicuous, the forth is elongated, little curved and smaller than the first. The tarsi are furnished with hairs. The last segment bears two sickle-like claws which are divided at the end interiorly and have one big

tooth at the base. This shape of claw is known to be the distinguishing characteristic of the genus *Epilachna*.

The abdomen is composed of eight visible (I-VIII) and 2 hidden tergites, and of 6 visible (II-VII) and 2 hidden sternites; the first sternite is wanting, the second is composed of two small triangular parts which lie on both sides between metathorax and abdomen; the first four segments (III-VI) are dark coloured in the middle; the intensity of coloration differ in young and old beetles; in young ones the coloration varies considerably on the first day; the 7th sternite has a crescent-shaped projection in the middle of the outer margin; the 8th sternite, which is hidden under the 7th sternite, is divided in the middle The genital opening lies between the 8th and 9th sternites. In the male, the first sternites (III-VI) are similar in form to those of the female; the 7th sternite has a smaller projection and is consequently similar to the 6th; the 8th sternite has, in the middle of the hind margin, a semi-circular cavity, which extends to the middle of this segment; the 9th sternite is invisible in normal condition. In the male the last sternites have fewer hairs than in the female. The male sexual organs are situated when contracted, in the left side of the abdomen and extend nearly over the whole length of the abdomen from sternites II-III to sternite VII. The sexual apparatus of the male is composed of two parts : to the first moveable part belongs one large arched body (sypho) which is thicker apically; the second part is composed of a group of constructions amongst which the sypho can move to the front and to the back; on the lower side of the thicker end of the sypho there are small teeth; the end itself is little divided; the sypho represents the extension of the thick inside-wall of the ductus ejaculatorius and is connected with the other parts of the copulation organ by a tube-like, syphonal skin; the aedeagus itself exhibits a pointed tube which is open at the top and has few bristles on its end, trabes and two parameres are connected with one another at the entrance of the sypho-tube (moveable) and build one part within which the sypho lies; the bristles of the aedeagus are characteristic for *Epilachna chrysomelina;* on the distal end of the lower side of the parameres there are also a few bristles. As already mentioned, this apparatus lies wholly in the abdomen whereby, the sypho and aedeagus are bent about 90° left to their longitudinal axis.

The egg

(Plate, figs. 2 and 3)

Elongate-oval, colour pale-yellow. The regular comb-like hexagonal structures of the egg-surface are visible under stronger magnification.

The larva

(Plate, figs. 4-8)

The newly hatched larva is light yellow, set with tender spines. The larva moults four times and thereby increases in size every time to nearly double of its previous size. The full grown larva is broad, dark-yellow, nearly fusiform. The back is covered with branched, strongly sclerotized spines. The anterior segments bear the stoutest spines, while the posterior ones have small, little divided, spines; each segment has six such spines. The body is, as usual, composed of three main parts: head, thorax and abdomen. The thorax is three-segmented, while the abdomen is ten-segmented. The head is dark brown, convex below, the frontal part bears a number of bristles, on both sides. Three simple eyes (ocelli) are found on each side of the head. The antennae are three-segmented, short. Clypeus and labrum are broad with few bristles. The mandibles are without hairs, sickle-like, with small teeth interiorly; these teeth are not set in one level as is the case in the adult. The maxillae are provided with bristles, and three-segmented maxillary palpi exteriorly. The mentum is rounded and bears two labial palpi each of which is two-segmented and has no bristles. The submentum is prolonged and is connected with the gula. The young larva has in the first hours after hatching light, smooth and little-divided spines, which become hard later on. The first segment of the thorax of a full grown larva bears 6 large divided spines, of which each two of the median four ones are placed on longish transverse dark excrescenses. The first and last spines arise singly on both sides of the body. On the second segment these same spines are placed far from one another. On this place, the skin splits during moulting. The last abdominal segments have many small and weak spines, the 9th and 10th segments have only a few simple bristles. The last segment has a sucking cup which enables the larva to move on smooth, steep surface. When gliding down or falling, the larva is always able to stick fast to the surface on which it moves; moreover, it uses the sucking-cup for holding fast during moulting-stages. The legs are coverd with hairs, the coxa and trochanter are strongly developed, femur short, tibia and tarsus are fused to one unit. The tarsus bears a strong claw at its end.

IV. BIOLOGY

The adult

(Plate, fig. 1)

The adult emerges from the pupal exuvia after having torn the skin in front by means of its mandibles, pushing its head through the hole. It comes forth slowly, tears the skin thereby longitudinally. In warm and dry weather the young adults emerge quickly, while in cold and moist weather

they often remain a few hours inside the torn skin. After emergence the soft, half transparent, wax-like, light-yellow coloured elytra of the young adults will soon become dark. After a few hours the spots of the elytra become visible, but their definite colour is strongly marked only after about one day. The newly emerged young adult remains a few hours motionless and begins to feed mostly on the next day. Both, males and females, are of regular occurrence. Sexual reproduction is the only way of propagation observed. During copulation the male sits on the back of the female, often for some days, with only short interruptions for egg-laying of the latter. A single pair may copulate up to six times.

TABLE II

Longevity of males

		GENERATIONS					TOTAL
		I	II	III	IV	V	
Periods		14.V to 10.VII	19.VI to 10.VIII	21.VII to 13.IX	21.VIII to 19.X	25.IX to 7.XII	
Males		65	64	56	59	69	313
Longevity in days	Minimum	1	1	1	1	1	1
	Maximum	58	53	55	60	74	74
	Average	19.87	18.10	18.75	20.69	25.35	20.55
Mean temperature in ^{0}C		25.5	28	27	24.5	20	

TABLE III

Longevity of females

		GENERATIONS					TOTAL
		I	II	III	IV	V	
Periods		14.V to 13.IX	19.VI to 21.X	21.VII to 10.XII	21.VIII to 6.II	25.IX to 4.IV	
Females		86	84	74	78	91	413
Longevity in days	Minimum	1	1	1	1	1	1
	Maximum	123	125	142	170	192	192
	Average	36.95	37.74	42.64	51.70	57.64	45.21
Mean temperature in ^{0}C		26.5	26	23	19	17	

The longevity of the adult male in the five successive generations obtained during the experimental studies in the laboratory (Table II) was as follows ; 1-58, 1-53, 1-55, 1-60, and 1-74 days, with the averages of 19.87, 18.10, 18.75, 20.69, and 25.35 days, respectively. The respective periods were : 14.v-10.vii, 19.vi-10.viii, 21.vii-13.ix, 21.viii-19.x, and 25.ix-7.xii. The mean temperature for these periods being 25.5, 28, 27, 24.5, and 20°

centigrades. The numbers of the adult males in these generations were 65, 64, 56, 59, and 69, consecutively.

The longevity of the adult female for the five generations (Table III) was as follows : 1-123, 1-125, 1-142, 1-170, and 1-192 days, with the averages of 36.95, 37.74, 42.46, 51.07, and 57.64 days, respectively. The respective periods were : 14.v-13.ix, 19.vi-21.x, 21.vii-10.xii, 21.viii-6.ii and 25.ix-4.iv. The mean temperature for these periods being 26.5, 26, 23, 19 and 17° Celsius. The numbers of the adult females in these generations were : 86, 84, 74, 78, and 91, respectively.

The ratio between males and females according to the data gathered in the five successive generations were : 75.6, 76.2, 75.7, 75.6, and 75.8 males to each hundred females in each generation, respectively. The ratio, according to Klemm (10), is about 92 males to 100 females.

TABLE IV

Pre-oviposition (from emergence to oviposition)

		GENERATIONS					TOTAL
		I	II	III	IV	V	
Periods		1.IV to 3.V	14.V to 10.VI	18.VI to 12.VII	21.VII to 11.VIII	21.VIII to 14.IX	
Females		7	7	7	7	7	35
Duration in days	Minimum	9	7	7	6	7	6
	Maximum	33	28	24	22	25	33
	Average	18.69	15.59	13.61	12.67	14.09	14.93
Mean temperature in °C.		20	24	27.5	29.5	26.5	

TABLE V

Oviposition period

		GENERATIONS					TOTAL
		I	II	III	IV	V	
Periods		20.IV to 15.VI	30.V to 17.VII	3.VII to 16.VIII	3.VIII to 19.IX	4.IX to 29.X	
Egg-masses		94	88	81	87	95	445
Duration in days	Minimum	1	1	1	1	1	1
	Maximum	57	49	45	48	56	57
	Average	24.66	21.37	19.56	20.98	24.15	22.13
Mean temperature in °C.		23	26.5	29	27	23.5	

Pre-oviposition

The pre-oviposition periods for the five generations (Table IV) were as follows : 1.iv-3.v, 14.v-10.vi, 19.vi-12.vii, 21.vii-11.viii, and 21.viii-

14.ix. The mean temperature for these periods being 20, 24, 27.5, 29.5, and 26.5 °C. These periods comprise two intervals, namely, one starting from emergence to copulation and the other from copulation to egg-laying. The whole pre-oviposition period for each of the five consecutive generations was : 9-33, 7-28, 7-24, 6-22, and 7-25 days, with an average of 18.69, 15.59, 13.61, 12.67, and 14.09 days, respectively. Willcocks (12) stated 7-12 days, and Klemm (10) about 16 days average for the pre-oviposition period.

Oviposition period

The oviposition periods for the five successive generations (Table V) were as follows : 20.iv-15.vi, 30.v-17.vii, 3.vii-16.viii, 3.viii-19.x, and 4.ix-29.x. Mean temperatures for these periods being : 23, 26.5, 29, 27, and

TABLE VI

Number of egg-masses per female

		GENERATIONS					TOTAL
		I	II	III	IV	V	
Periods		20.IV to 15.VI	30.V to 17.VII	3.VII to 16.VIII	3.VIII to 19.IX	4.IX to 29.X	
Females		7	7	7	7	7	35
Number of egg-masses per female	Minimum	1	1	1	1	1	1
	Maximum	36	34	31	33	37	37
	Average	13.40	12.62	11.55	12.39	13.66	12.72
Mean temperature in °C		23	26.5	29	27	23.5	

TABLE VII

Number of eggs per egg-mass

		GENERATIONS					TOTAL
		I	II	III	IV	V	
Periods		20.IV to 15.VI	30.V to 17.VII	3.VII to 16.VIII	3.VIII to 19.IX	4.IX to 29.X	
Egg-masses		94	88	81	87	95	445
Number of eggs per egg-mass	Minimum	1	1	1	1	1	1
	Maximum	54	51	47	50	55	55
	Average	22.57	21.27	19.46	20.88	23.02	21.44
Mean temperature in °C		23	26.5	29	27	23.5	

23.5 °C. It took the female in these generations to lay its eggs : 1-57, 1-49, 1-45, 1-48, and 1-56 days, with an average of 24.66, 21.37, 19.56, 20.98, and 24.15 days, respectively.

The egg

(Plate, figs. 2 and 3)

Eggs are generally deposited in masses mostly on the lower surface of a leaf, but occasionally they are laid on the upper surface of the leaf and on the stem as well, but never on the soil. Deposited eggs are fixed mostly vertically with the broad end stuck to the supporting surface. Young females often lay their eggs scattered, irregularly or singly and in different directions. The majority of such eggs dry up. Egg-masses in which the eggs stood regu-

TABLE VIII

Number of eggs per female

	GENERATIONS					TOTAL
	I	II	III	IV	V	
Periods	20.IV to 15.VI	30.V to 17.VII	3.VII to 16.VIII	3.VIII to 19.IX	4.IX to 29.X	
Females	7	7	7	7	7	35
Number of eggs per female — Minimum	11	10	9	10	11	9
Number of eggs per female — Maximum	541	510	466	500	551	551
Number of eggs per female — Average	287.1	270.6	247.6	265.6	292.8	272.74
Mean temperature in °C	23	26.5	29	27	23.5	

TABLE IX

Incubation period (from oviposition to hatching)

	GENERATIONS					TOTAL
	I	II	III	IV	V	
Periods	20.IV to 23.V	30.V to 27.VI	3.VII to 29.VII	3.VIII to 30.VIII	4.IX to 4.X	
Oviposited eggs	2010	1894	1733	1859	2050	9546
Hatched eggs	638	718	615	594	663	3228
Mortality percentage	68.3	62.1	64.5	68	67.7	66.1
Duration in days — Minimum	4	4	3	3	3	3
Duration in days — Maximum	9	8	7	7	7	9
Duration in days — Average	5.08	4.45	3.81	3.69	4.11	4.23
Mean temperature in °C	21	24	28	29	26	

larly and vertically gave the highest percentage of hatched larvae. The egg-laying process goes on normally except when the female is disturbed, in which case it lays its eggs scattered and irregular. Eggs deposited under unfavourable conditions usually shrink and dry up. According to Klemm (10) fertilised and non-fertilised eggs occur not seldom beside each other in one egg-mass.

The numbers of egg-masses per female for the five generations (Table VI) were as follows: 1-36, 1-34, 1-31, 1-33, and 1-37 egg-masses, with an average

of : 13.40, 12.62, 11.55, 12.39, and 13.66, respectively. The mean temperatures being : 23, 26.5, 29, 27, and 23.5 °C.

The numbers of eggs per egg-mass for the five generations (Table VII) were as follows: 1-54, 1-51, 1-47, 1-50, and 1-55 eggs, with an average of 22.57, 21.27, 19.46, 20.88, and 23.02, respectively. The mean temperatures being the same as before.

The numbers of eggs per female for the five successive generations (Table VIII) were as follows : 11-541, 10-510, 9-466, 10-500, and 11-551 eggs, with an average of 287.1, 270.6, 247.6, 265.6, and 292.8 eggs, respectitvely. The mean temperatures being 23, 26.5, 29, 27, and 23.5° C.

After Klemm (10), the number of eggs per female amounted to 322 eggs collected from 10 egg-masses. The number of eggs per egg-mass was ranging from 10-30 eggs and reached 40 eggs in some cases. Willcocks (12) recorded 600 eggs per female.

Incubation period

The incubation periods of the five generations (Table IX) were as follows : 20.iv-23.v, 30.v-27.vi, 3.vii-29.vii, 3.viii-30.viii, and 4.ix-4.x. The mean temperatures of these periods being : 21, 24, 28, 29, and 26° C.

The number of eggs deposited, of larvae hatched there from, and the percentages of mortality for each of the five successive generations were as follows : 2010-638 (68.3 % mortality), 1894-718 (62.1 % mortality), 1733-516 (64.5 % mortality), 1859-594 (68 % mortality), and 2050-663 (67.7 % mortality).

The duration of the egg-stage for the five generations was as follows : 4-9, 4-8, 3-7, 3-7, and 3-7 days, with an average of 5.08, 4.45, 3.81, 3.69, and 4.11 days, respectively.

According to Klemm (10) and Willcocks (12) the incubation period ranged from 5 to 6 days. In the experimental studies at Dokky, the author observed that most of the eggs laid in the fifth generation after the period 4.x. dried up, and that some hatched but died after one or two or even three instars as a result of the unfavourably low temperature of the advancing cold weather in autumn.

The larval stages

Before hatching, the egg loses its brightness and becomes dull and somewhat dark. The hatching larva bites through the shell in the upper pole, making a small opening, through which it pushes its head, holding the rim of the opening with its maxillae and starts to widen the opening by pushing the front part of its body. This operation is helped by the back, in such a way, that the egg-shell is pushed backwards with the end of the body. In the meantime the young larva holds to the rim of the opening, bending its

back strongly and pushing the end of its body forwards, thus arching its back higher up, causing the hole to be more widely split and allowing its body to pass easily through, leaving the egg-shell behind. The larva rests several hours after hatching, keeping itself in a crooked position on the empty egg-shell without taking in any food.

The newly hatched larva is light-yellow with soft fine spines. Within few hours the larva becomes dark grey-yellow, its spines harden and soon afterwards the larva begins to feed.

During moulting, the larva sits, by means of the sucking mechanism of the legs, on any substratum remains quiet for several hours and then comes forth leaving its cast skin on the substratum. The freshly moulted larva is light-yellow and bears also white fine spines like those of the first stage larva only it is 1.2 as large in the former than in the latter. After moulting the larva rests for a few hours in a crooked position, then attains its normal grey-yellow colour and begins to feed. After each moulting, the larva becomes twice as large as before. Capacity of feeding and moving increases thereby every much. In the fourth larval-stage the larva, according to Klemm (10) shows an inclination to cannibalism even when food is abundant. During this instar the larva attains its largest size and feeds more greedily. At the end of this stage the larva, after having completed its development, fixes itself with the posterior portion of the body to a rough substratum by means of a secretion which, according to Klemm (10), is formed in the malpighian tubes and which hardens when exposed to air. Other authors relate this secretion to special silk glands found in the last abdominal segments. The larva remains in this state for a few days never feeding, shrivels up and becomes sluggish and the mortality in this phase is apparently high. Klemm believes that the high mortality is due to cannibalism and that these sluggish larvae are easily preyed upon by the active larvae. Cannibalism, however, was never noticed by the author. Klemm calls this phase of the last larva prepupa. The author does not wish, however to adopt this term, as this phase is not fully homologous with the true prepupae of other orders of insects.

First instar

(Plate, fig. 4)

The periods of the larva, first instar, for the five consecutive generations (Table X), were as follows : 25.iv-25.v, 3.vi-28.vi, 7.vii-31.vii, 7.viii-31.viii, and 8.ix-2.x. The mean temperatures for these periods being 21, 25, 28, 29, and 26° C. The numbers of hatched larvae, of larvae moulted for the first time and mortality percentage of each generation, were as

TABLE X

First larval stage

		GENERATIONS I	II	III	IV	V	TOTAL
Periods		25.IV to 25.V	3.VI to 28.VI	7.VII to 31.VII	7.VIII to 31.VIII	8.IX to 2.X	
Cases	hatching	638	718	615	594	663	3228
	to first moulting	424	459	409	396	442	2130
Mortality percentage		33.5	36.1	33.5	33.3	33.3	34
Duration in days	Minimum	3	2	2	2	2	2
	Maximum	6	5	5	4	5	6
	Average	3.35	2.82	2.51	2.42	2.70	2.76
Mean temperature in °C		21	25	28	29	26	

TABLE XI

Second larval stage

		GENERATIONS I	II	III	IV	V	TOTAL
Periods		28.IV to 27.V	6.VI to 1.VII	9.VII to 2.VIII	9.VIII to 3.IX	11.IX to 9.X	
Cases	first moulting	424	459	409	396	442	2130
	to second moulting	341	362	312	317	354	1686
Mortality percentage		19.6	21.1	23.7	19.9	19.9	20.8
Duration in days	Minimum	1	1	1	1	1	1
	Maximum	6	5	5	4	5	6
	Average	2.64	2.27	1.96	2	2.23	2.22
Mean temperature in °C		21.5	25	29	28.5	25.5	

TABLE XII

Third larval stage

		GENERATIONS I	II	III	IV	V	TOTAL
Periods		1.V to 30.V	8.VI to 3.VII	11.VII to 3.VIII	11.VIII to 4.IX	13.IX to 11.X	
Cases	second moulting	341	362	312	317	354	1686
	to third moulting	286	298	257	266	298	1405
Mortality percentage		16.1	17.7	17.6	16.1	15.8	16.7
Duration in days	Minimum	1	1	1	1	1	1
	Maximum	5	5	4	4	5	5
	Average	2.62	2.30	1.99	2.05	2.30	2.25
Mean temperature in °C		22	25	29	28	25	

follows : 638-424 (33.5% mortality), 718-549 (36.1% mortality), 615-409 (33.5% mortality), 594-396 (33.3% mortality), and 663-442 (33.3% mortality).

The duration of this stage for the five generations was as follows : 3-6, 2-5, 2-5, 2-4, and 2-5 days, with an average of 3.35, 2.82, 2.51, 2.42, and 2.7 days, respectively.

Klemm (10) stated 4-5 days for the duration of the first larval instar.

TABLE XIII

Fourth larval stage

		GENERATIONS I	II	III	IV	V	TOTAL
Periods		4.V to 4.VI	10.VI to 6.VII	13.VII to 6.VIII	13.VIII to 7.IX	15.IX to 14.X	
Cases	third moulting	286	298	257	266	298	1405
	to fourth moulting	197	197	176	182	204	956
Mortality percentage		31.1	33.9	31.5	31.6	31.5	32
Duration in days	Minimum	3	2	2	2	3	2
	Maximum	7	6	5	5	6	7
	Average	3.59	4.56	4.08	4.23	4.74	4.60
Mean temperature in °C		22	26	29	28	25	

TABLE XIV

Pupal stage

		GENERATIONS I	II	III	IV	V	TOTAL
Periods		9.V to 9.VI	15.VI to 11.VII	17.VII to 10.VIII	17.VIII to 12.IX	20.IX to 20.X	
Cases	fourth moulting	197	197	176	182	204	956
	to emergence	151	148	130	137	160	726
Mortality percentage		23.3	24.9	26.1	24.7	21.6	24
Duration in days	Minimum	4	4	3	3	4	3
	Maximum	7	6	5	6	7	7
	Average	5.09	4.40	3.87	4.08	4.76	4.44
Mean temperature in °C		22.5	26	29.5	28	24	

Second instar

(Plate, fig. 5)

The periods of the second larval stage, for the five generations (Table XI), were as follows : 28.iv-27.v, 6.vi-1.vii, 9.vii-2.viii, 9.viii-2.ix, and 11.ix-9.x. The mean temperatures for these periods being 21.5, 25, 29, 28.5, and 25.5° C.

The numbers of the first stage and second stage larvae and mortality percentage for each generation were as follows : 424-341 (19.6% mortality), 459-362 (21.1% mortality), 409-312 (23.7% mortality), 396-317 (19.9% mortality), and 442-354 (19.9% mortality).

The duration of this instar in the five generations being 1-6, 1-5, 1-5, 1-4, and 1-5 days, with an average of 2.64, 2.27, 1.96, 2, and 2.23 days, respectively.

According to Klemm (10), this instar needed 4-6 days to develop.

TABLE XV

Average life-cycle of all generations

		GENERATIONS					TOTAL
		I	II	III	IV	V	
Periods		1.IV to 9.VI	14.V to 11.VII	19.VI to 10.VIII	21.VII to 12.IX	21.VIII to 20.X	
Adults		151	148	130	137	160	726
Duration in days	Minimum	25	21	19	18	21	18
	Maximum	45	38	33	32	36	45
	Average	43	36.3	31.8	34.7	34.9	35.43
Mean temperature in °C		20.5	24.5	28	29	25.5	

Third instar

(Plate, fig. 6)

The periods in which the third instar developed in the five successive generations (Table XII), were as follows : 1.v-30.v, 8.vi-3.vii, 11.vii-3.viii, 11.viii-4.ix, and 13.ix-11.x. The mean temperatures for these periods being 22, 25, 29, 28, and 25° C.

The numbers of the second and third stage larvae and the percentage of mortality of each generation were as follows : 341-286 (16.1% mortality), 362-298 (17.7% mortality), 312-257 (17.6% mortality), 317-266 (16.1,% mortality), and 354-298 (15.8% mortality).

The duration of the third instar for the five generations were as follows : 1-5, 1-5, 1-4, 1-4, and 1-5 days, with an average of 2.62, 2.30, 1.99, 2.05, and 2.30 days.

Klemm (10) stated 4-6 days for the duration of this instar.

Fourth instar

(Plate, figs. 7 and 8)

The periods of the fourth larval stage for the five generations (Table XIII) were as follows : 4.v-4.vi, 10.vi-6.vii, 13.vii-6.viii, 13.viii-7.ix, and 15.ix-14.x. The mean temperatures for these periods being 22, 26, 29, 28, and 25° C.

The numbers of the third and fourth stage larvae and the percentage of mortality for each generation were as follows: 286-197 (31.1% mortality), 298-197 (33.9% mortality), 257-176 (31.5% mortality), 266-182 (31.6% mortality), and 298-204 (31.5% mortality).

The duration of this instar for the five generations was as follows: 3-7, 2-6, 2-5, 2-5, and 3-6 days, with an average of 5.39. 4.56, 4.08, 4.23, and 4.74 days, respectively.

According to Klemm (10) the duration of this instar reached 7-9 days. Willcocks (12) stated 14 days for the duration of the whole larval stage, including the four instars.

The pupa

(Plate, fig. 9)

At the end of the fourth larval stage the pupa tears open the skin on its back, contracts itself and bends backwards in order to widen the hole. After one minute the anterior half of the body protrudes through the hole. Gradually, the skin is pushed backwards and the pupa moves its anterior part right and left once or twice every minute, thus setting all its body free. These sidewise movements continue for about half an hour and cease gradually thereafter. During this time the skin is contracted backwards on both sides and the pupa appears with its light-yellow colour and two conspicuous rows of dark spots and single fine hairs on the sides. The pupa is broad with blunt front end. A few hours after moulting it becomes dark yellow. In the middle, dark transverse lines appear and the black spots become more visible. The skin and the spines change into black.

The periods of the pupal stage for the five generations (Table XIV) were as follows: 9.v-9.vi, 15.vi-11.vii, 17.vii-10.viii, 17.viii-12.ix, and 20.ix-20.x. The mean temperatures for these periods being 22.5, 26, 29.5, 28, and 24° C.

The numbers of the pupae, adults emerged and the percentage of mortality of each generation were as follows: 197-151 (23.3% mortality), 197-148 (24.9% mortality), 176-130 (26.1% mortality), 182-137 (24.7% mortality), and 204-160 (21.6% mortality).

The durations of the pupal stage for the five generations were as follows: 4-7, 4-6, 3-5, 3-6, and 4-7 days, with an average of 5.09, 4.40, 3.87, 4.08, and 4.07 days, respectively.

Willcocks (12) recorded five days for the duration of the pupal stage, while Klemm (10) stated 5-7 days.

The life-cycle

The duration of a whole life cycle of each generation was as follows: 25-45, 21-38, 19-33, 18-32, and 21-36 days, with an average of 43, 36.3,

31.8, 30.7, and 34.9 days, respectively. Mean temperatures being 20.5, 24.5, 28, 29, and 25.5° C.

Taking the total average percentage of mortality of all generations for each stage of development the data will be as follows :

Egg, 66.1% ; larva 1st instar, 34% ; larva 2nd instar, 20.8% ; larva 3rd instar, 16.7% ; larva 4th instar, 32% ; pupa, 24%.

According to the above mentioned figures one could easily notice that the beetle has the highest mortality percentage in the egg-stage followed by the larval 1st and 4th instar consecutively. The larval 3rd instar is the most resistant stage as it has the lowest mortality percentage, followed by the 2nd larval instar. Most of the larvae 4th instar die at the end of this stage within the last few days before moulting to the pupal stage.

Number of generations

According to the experimental studies at Dokky, the number of generations observed under laboratory conditions within six months was five. The variation range in the duration of each stage within one generation was wide, but taking the duration of one generation as a whole, this variation range was shortened and the duration more closely approached the average (Table XV). The periods of the different generations were as follows : 1.iv-9.vi, 14.v-11.vii, 19.vi-10.viii, 21.vii-12.ix, and 21.viii-20.x. Mean temperatures for these periods beng 20.5, 24.5, 28, 29, and 25.5° C. Under natural conditions the same number of generations was maintained.

From the above dates it appears that considerable overlapping of the generations takes place.

Klemm (10) stated in his studies four generations within six months and was of the opinion that the number of generations might increase under warmer conditions. Bodenheimer (1) recorded five generations in Palestine, the first generation of which appeared in June, while in Egypt the first generation occured already in the beginning of April. The adults that emerged from the fifth generation copulated and laid eggs in very rare cases. This occured only in exceptionally hot weather holding on for several days or even weeks in the early autumn. These late eggs, however, shriveled and dried up and never came to further development.

Hibernation

Willcocks (12) stated that *Epilachna* hibernates in the adult stage. Some believe that hibernating adults are found on borders of fields, amongst weeds growing along canals. According to Priesner, the adults migrate during winter to the desert in the neighbourhood of cultivated lands. He collected the hibernating beetles several times on *Citrullus colocynthus* in Wadi Hof and Wadi Digla in the neighbourhood of Helwan and Maadi.

The author is more inclined to the last statement as he never found the adults hibernating during winter in the fields or along canals. Beetles fly back from the desert to cultivated lands in the early spring. The moderate climate of Egypt during winter allows feeding of the hibernating beetles naturally on wild cucurbitaceous plants as the latter rarely grow in winter in cultivations. The feeding capacity of the hibernating adults is naturally lowered to a minimum. In the early spring, the adults become more active, begin to feed greedily and around the beginning of April they start to copulate and lay eggs. The adults emerged from the fifth generation hibernated during winter about six and half months in captivity. According to Klemm (10) the adults may live up to two years.

Host-plants

In Egypt, plants of the family Cucurbitaceae are the only host plants of *Epilachna chrysomelina*. Willcocks (12) and Klemm (10), both state the same fact. Bodenheimer recorded the same host plants for this beetle in Palestine. Sorauer (11) adds to the cucurbitaceous plants : Sesam (in East Africa, known as German East Africa previously), Cotton plants (in Southern Nigeria) as host plants for this beetle.

Injury and nature of damage

Both adult and larva feed on leaves and fruits of their host plants, belonging chiefly to the family Cucurbitaceae. The insect eats all the leaf-tissue leaving only the veins. Such injured leaves dry quickly and the plant dies soon. By feeding on the fruits, the beetles make large holes on which patches of rotten tissue appear later on. Young stems are often gnawed round spiral-like, so that they easily break. The beetles fly well and the larvae crawl from one plant to another, both causing great damage in a short time. Klemm (10) states that the adult and sometimes the larva of the last stage feed on the lower surface of a fresh leaf, first cutting a nearly regularly curved line, both ends of which meet at the margin of the leaf. This work is presumably done by the insect for the sake of lowering the water content of the green parts. The spiral-like gnawing of the young stems serves the same purpose. The insect feeds on the upper-surface of the leaf as well. Feeding is not confined to certain periods by day or night. Beetles can live without food for several days.

Geographical distribution

According to Sorauer (11) and Klemm (10) this insect is distributed in Turkestan and in the Mediterranean Region, namely, in South Europe, the Middle East and North and South Africa. Moreover, it is found in

East Africa, Nigeria and Sudan. Egypt belongs partly to the Mediterranean Region and the beetle is found all over the country only with different intensity of population according to different ecological factors.

Natural enemies

Up to the present time none of the natural enemies of this beetle has been discovered in Egypt. Records on this subject from other countries are not known to the author. Only Klemm (10) described a bacterial disease which injured the larvae during his experiments as to the life history of this insect.

The effect of combined temperature and humidity on the incubation period and mortality percentage of the eggs of Epilachna.

These studies were carried on in a multiple thermostat containing ten chambers in which the temperatures were arranged as follows : 18, 20, 22, 24, 26, 28, 30, 32, 34, and 36° C.

These temperatures were kept constant with a variation range of ± 0.25° C. In each chamber there were six petri-dishes with six different relative humidities which were obtained by means of water and different concentrations of sulphuric acid and potassium hydroxide (caustic potash) as follows :

100% water, 90% dil. sulphuric acid (H_2SO_4) (sp. gr. 1.19), 70% dil. sulphuric acid (H_2SO_4) (sp. gr. 1.25), 50% caustic potash (KOH) (sp. gr. 1.335) 30% dil. sulphuric acid (H_2SO_4) (sp. gr. 1.41), 10% caustic potash (KOH) (sp. gr. 1.57).

For these studies, eggs were particularly chosen to eliminate the feeding factor, thus avoiding its effect on the mortality percentage of other stages. Twenty eggs were put in each petri-dish, 8.5 cms. in diameter and 2.5 cms. in height. The upper rim of the dish had a furrow to allow binding a muslin cover over the dish with a rubber band. The leaf with the twenty eggs on it was carefully put on the muslin cover, while in the dish there was the respective solution for the relative humidity. Above the muslin was put another petri-dish, face downwards, 1 cm. less in diameter to leave a space of half a centimeter all around for ventilation. It took about one month to complete this experiment which was repeated thrice during the season.

The data obtained comprised both duration of egg period and percentage of mortality. In Table XVI the durations of this stage both (a) calculated and (b) empirical are shown. The calculation is made according to Janisch's (2-6) and Janisch's and others' (7-9) formulae in this respect, based on the authors' empirical figures observed on 22, 24, and 26° C. com-

bined with the different degrees of relative humidities. The formulae being :

$$\text{(I) } t = \frac{m}{2}\left(a_1^{T} + a_2^{-T}\right); \text{ (II) } a_1^{T} = p \text{ and } a_2^{T} = q;$$

$$\text{(III) } p = \frac{t_1}{m} + \sqrt{\left(\frac{t_1}{m}\right)^2 - \frac{t_1}{t_2}}; \text{ (IV) } q = 2\frac{t_2}{m} - \frac{1}{p};$$

$$\text{and (V) } \log a_1 = \frac{\log p}{T} \text{ and } \log a_2 = \frac{\log q}{T}$$

It appears necessary to explain the letters of the above mentioned formulae and what they stand for :

TABLE XVI

Egg-stage : Duration in days under different combined degrees of temperature and relative humidities

Temperature in °C		12	14	16	18	20	22	24	26	28	30	32	34	36
Relative humidity 90 %	a....	17.3	13.5	10.6	8.4	6.6	5.28	4.18	3.32	2.7	2.2	1.7	1.4	1.1
	b....	—	—	—	9-11	7-9	5.28-7	4.18-6	3.32-5	3-4	3-4	2-3	—	—
Relative humidity 70 %	a....	18.3	14.3	11.2	8.9	7	5.64	4.54	3.68	3	2.5	2	1.7	1.4
	b....	—	—	—	9-11	7-9	5.64-7	4.54-6	3.68-5	3-4	3-4	2-3	—	—
Relative humidity 100 %	a....	18.5	14.7	11.6	9.3	7.5	6.08	4.98	4.12	3.5	2.9	2.5	2.1	1.9
	b....	—	—	—	9-11	8-10	6.08-8	4.98-7	4.12-6	4-5	3-4	3-4	—	—
Relative humidity 50 %	a....	19.6	15.4	12.3	9.9	8	6.62	5.52	4.66	4	3.4	3	2.7	2.4
	b....	—	—	—	10-12	8-10	6.62-8	5.52-7	4.66-6	4-5	4-5	—	—	—
Relative humidity 30 %	a....	20.5	16.6	13.2	10.6	8.7	7.3	6.18	5.4	4.8	4.3	3.95	3.7	3.4
	b....	-	—	—	11-13	9-11	7.3-9	6.18-8	5.4-7	5-6	5-6	—	—	—
Relative humidity 10 %	a....	22	17.5	14.1	11.5	9.6	8.12	6.98	6.12	5.5	5.1	4.65	4.4	4.2
	b....	—	—	—	—	10-12	8.12-10	6.98-9	6.12-8	6-7	—	—	—	—

a : calculated (days) — b : empirical (days)
90% R.H. a_1=0.9200 and a_2=1.1530
70% R.H. a_1=0.9541 and a_2=1.1570
100% R.H. a_1=0.9358 and a_2=1.1580
50% R.H. a_1=0.9692 and a_2=1.1550
30% R.H. a_1=0.9965 and a_2=1.1580
10% R.H. a_1=1.0020 and a_2=1.1500

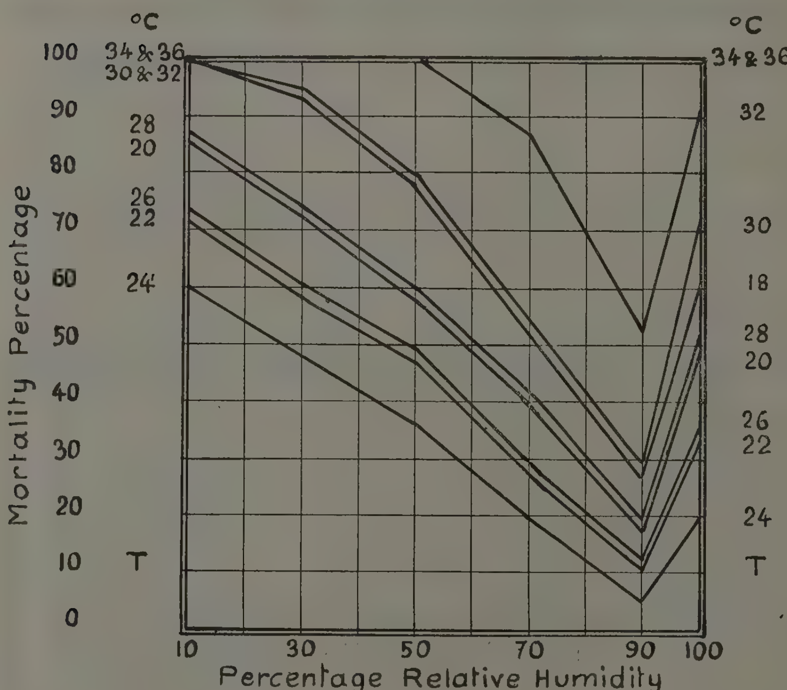
m = duration of a certain stage of insect at the optimum temperature in conneection with a certain relative humidity ; t = duration of a certain stage at a certain combination of temperature and relative humidity ; T = temperature ; a_1 and a_2 = two mathematical constants ; t_1 = duration of a certain stage on a certain combination of temperature and relative humidity

above the optimum; t_2 = duration of a certain stage on a certain combination of temperature and relative humidity below the optimum.

For the calculation of a_1 and a_2 in the formula, t_1 and t_2 given above should be taken at equal distance (= number of degrees of temperature) from both sides of the optimum. The optimum is considered, biologically and mathematically as well, to lie at zero point. All temperatures above the optimum (= on its right side) are preceded by + (positive), while those below (= on its left side) are preceded by — (negative).

GRAPH I

Egg-stage : Mortality percentage

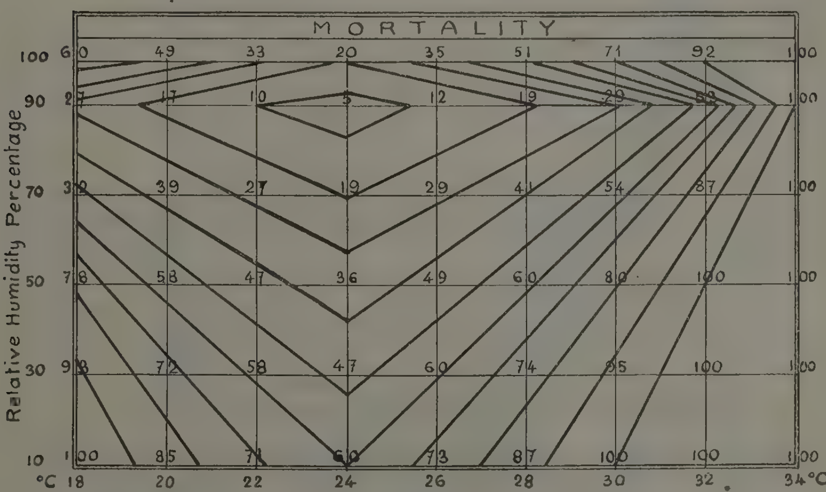


The figures in Graph I show the mortality percentage of the egg-stage under each combination of temperature and relative humidity, while Graph II combines the similar mortality percentages in the different combinations of temperature and relative humidity. Graph III exhibits the duration of the stage under the above mentioned combinations of temperature and relative humidity.

From these Graphs one can easily conclude that 24° C and 90% R.H. combined together represent the optimum for the egg-stage of *Epilachna*. In the mean time, it appears that the critical degrees of temperature for the development of this stage are above 30°C and below 18°C. From Graph II it may be concluded that the mortality percentage rises more rapidly with the rise of temperature above the optimum than it does with the fall of temperature below the optimum. With regard to humidity, the further the conditions are from the optimum (90% R.H.) the higher appear the mortality percentages. The rate of mortality under the conditions from 90 to 70% R.H. is less than it is from 90 to 100% R.H. A relative humidity of at least 70% is needed for a satisfactory development of the egg-stage. This fact may explain why the beetle is more widely spread in Lower Egypt than in Upper Egypt, especially in Summer, where the temperature is much higher and the humidity is much lower than the degrees favourable to this insect.

GRAPH II.

Egg-stage : Isomers of mortality percentage



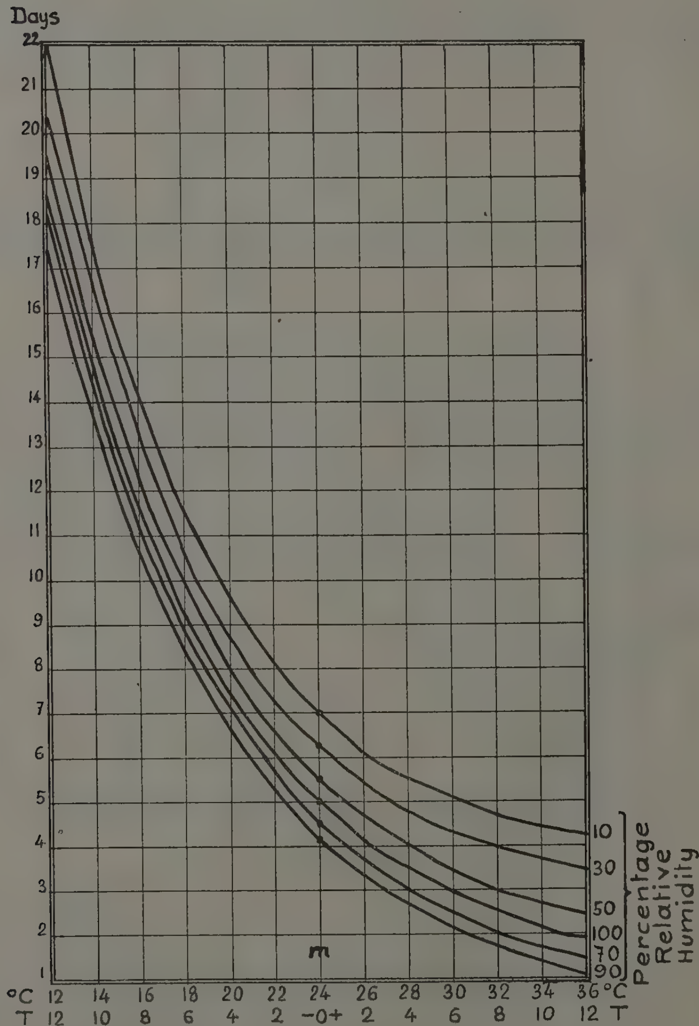
V. CONTROL

The following insecticides were teested under field conditions in dust form :

(A) Agrocide III dust containing 5% 666 (H.C.B.) ; (B) Gesarol 5% D.D.T. ; (C) Gamtox containing 50% H.C.B. isomers, diluted with sulphur at the ratio of 1 : 9 ; (D) Persisto containing 50% D.D.T., diluted with sulphur 1 : 9 ; and (E) Calcium arsenate lime sulphur, prepared at the formula 1 : 1 : 1 (calcium arsenate contained 40% of fifth oxide of arsenic and not more than 0.5 free acid).

GRAPH III

Egg-stage : Incubation period in days. Combination of temperatures and relative humidities (calculated according to the formula Janisch) (see Text).



Agrocide III dust was delivered from the I.C.I. (England), Gesarol from Geigy (Switzerland), Gamtox and Persisto from the California Spray Chemical Corporation (U.S.A.).

The experiment was carried out in a field of water-melon at the Delta-Barrage in an area of about 3/8 of a feddan (acre). The area was divided into 30 plots, 5 of each for every insecticide chosen at random and 5 were left untreated as control. The area of each plot was about 1/80 of a feddan, i.e. 52.5 square metres (7 ms. × 7.5 ms.), containing about 50 plants; the area for each plant about 1 square meter (125 cms. × 80 cms.).

TABLE XVII

Dusting experiments under field conditions : two treatments (the first carried out on 20th May 1948, the second applied on 30th May 1948)

	FIRST COUNTING 31.V.1948			SECOND COUNTING 10.VI.1948			THIRD COUNTING 20.VI.1948		
	INSECTS MORTALITY			INSECTS MORTALITY			INSECTS MORTALITY		
	ALIVE	DEAD	PERCENTAGE	ALIVE	DEAD	PERCENTAGE	ALIVE	DEAD	PERCENTAGE
A	2	69	97.2	51	97	65.5	60	69	53.5
B	2	69	97.2	45	103	69.6	54	75	58.1
C	2	70	98.6	50	98	66.2	56	73	56.6
D	1	70	98.6	42	106	71.6	52	77	59.7
E	7	64	90.1*	69	79	53.1	78	51	39.5
Check ...	71	0	0	158	0	0	129	0	0

*Data given above for insecticide E for the third day after second treatment. The figures showing kill percentage of E for four days following second treatment being :

	31.V	1.VI	2.VI	3.VI
Check	71	69	71	73
Alive	35	19	7	9
Dead	36	50	64	62
Mortality percentage ..	50.7	72	90.1	85

The data given in the Tables were obtained from samples taken at random from 5 plants in each plot for each counting, i.e. 25 plants for each insecticide. Each plot was treated twice with an interval of 10 days at the ratio of 8-10 kgrs. per feddan for each treatment.

The counts made after the first treatment showed that the figures obtained from all insecticides were so poor that they had to be neglected, and thus only the counts after the second treatment were recorded in Table XVII. The unsatisfactory results obtained from the first treatment were undoubtedly due to the fact that most of the insects on the crop during the first application were in the egg-stage which was more resistant to the

insecticides. Three countings were taken, namely the first, one day after second treatment, the second ten days later and the third and last twenty days after second treatment. In the case of calcium arsenate lime sulphur, which is known for its comparatively slow-effect, the first count was taken after 1, 2, 3, and 4 days. The results showed that the highest mortality was reached on the third day and for that reason only the highest results were recorded in the Table.

From the figures shown in Table XVII one may conclude the following:

(A) The materials tested may be divided into three groups according to their quickness in toxic action, as could be observed from the first counting :

(1) Gamtox and Persisto, (2) Agrocide III and Gesarol, and (3) Calcium arsenate lime sulphur.

(B) With regard to residual effect as observed from the third counting, the insecticides can be arranged into the following descending order :

(1) Persisto, (2) Gesarol, (3) Gamtox, (4) Agrocide III, and (5) Calcium arsenate lime sulphur.

TABLE XVIII

Dusting experiments (1949) under laboratory conditions

MINUTES	I. E. 605 (2 % active ageut)			II. AGROCIDE III (5 % 666)			III. GESAROL (5 % D.D.T.)		
	ADULTS MORTALITY			ADULTS MORTALITY			ADULTS MORTALITY		
	ALIVE	DEAD	PERCENTAGE	ALIVE	DEAD	PERCENTAGE	ALIVE	DEAD	PERCENTAGE
5	34	6	15	36	4	10	38	2	5
10	21	19	40.5	25	15	37.5	34	6	15
15	4	36	90	14	26	65	30	10	25
20	0	40	100	9	33	77.5	24	16	40
25	—	—	—	2	38	95	16	24	60
30	—	—	—	0	40	100	11	29	72.5
35	—	—	—	—	—	—	7	33	82.5
40	—	—	—	—	—	—	4	36	90
45	—	—	—	—	—	—	2	38	95
50	—	—	—	—	—	—	0	40	100

	Comparative quickness of toxic action :		
Area (20 cms. diam.) = 314 sq. cms.			
Amount of dust applied = 0.3 grams	I	II	III
Number of insects = 40 adults	1 :	1.5 :	2.5

(C) Taking the average kill percentage of the three countings one may arrange the tested insecticides in the following descending order :

(1) Persisto 76.6% kill, (2) Gesarol 74.97%, (3) Gamtox 73.8%, (4) Agrocide III 72.1%, and (5) Calcium arsenate lime sulphur 61%.

The last treatment should be stopped at least four weeks before harvest in order to avoid any bad effect of the residue of these poisonous insecticides

to the consumer. In case of marrow and cucumber hand picking of the insects should be carried out in the evening and early morning when the insects are sluggish. This method of control is recommended in this case because harvesting the crop of marrow and cucumber is carried on and repeated usually after short periods (a few days) which are not long enough to avoid the bad residual effect of such poisonous insecticides under natural conditions, either by decomposition or partial wash-off.

In the above mentioned experiment the quickness of toxic action of the tested insecticides was compared after the lapse of 24 hours after 2nd treatment. It was thought advisable to carry out an experiment in the laboratory to compare quickness of toxic action at shorter times. For this reason 40 adults for each insecticide were put on a glass surface under a bell jar with an opening on top closed by a rubber stopper through which was inserted a glass tube bent at a right angle, 10 cms. long on both sides and 2 cms. in diameter. In the outer branch of the glass tube a curved plate of copper with 0.3 gram of the insecticide was put; the end of the tube was closed with a rubber stopper through which was inserted the mouth of an air blower to blow the insecticide inside the bell jar, thus causing the dust to fall on the insects below.

The doses used in this experiment for each insecticide were 3 times as much as it necessarily should be in consequence of its very small quantity which is practically impossible to apply. The insecticides tested in this experiment being :

(1) E 605 dust (containing 75% para-nitrophenyl-diethyl-thiophosphate) used at 2% (delivered by Bayer, Leverkusen, Germany); (2) Agrocide III containing 5% (666); and (3) Gesarol containing 5% D.D.T.

After treatment the adults become sooner or later paralysed and are considered dead the moment they turn over on their backs.

As shown in Table XVIII, the quickest insecticide in toxic action was E 605 when 100% kill was obtained after 20 minutes from treatment, followed by Agrocide III which took 30 minutes to get 100% kill, and the last was Gesarol in which 100% kill was reached after 50 minutes. The ratio of quickness of toxic action of these three insecticides tested was: 1:1.5:2.5.

VI. ACKNOWLEDGMENT

I take the opportunity to tender my gratitude and thanks to Mohamed Soliman El-Zoheiry Bey, General Director, Plant Protection Department, Prof. Dr. H. Priesner, Entomological Expert, to Mr. A. Alfieri, General Secretary Fouad Ist Entomological Society, Cairo, and to all my assistants and colleagues who have been always ready to give help and advice.

VII. BIBLIOGRAPHY

(1) Bodenheimer, F.S. (1930) : Die Schädlingsfauna Palästinas (pp. 340-343).

(2) Janisch, E. (1927) : Das Exponentialgesetz als Grundlage einer vergleichenden Biologie (Springer, Berlin).

(3) Janisch, E. (1929) : Ueber die Wirkungsgrösse der Umweltfaktoren bei der Massenvermehrung der Insekten (*Deutsche Forschung*, h.9, p. 80).

(4) Janisch, E. (1930-1931) : Experimentelle Untersuchungen über die Wirkung der Umweltfaktoren auf Insekten. I. Die Massenvermehrung der Baumwolleule *Prodenia littoralis* in Aegypten (*Ztschr. f. Morph. u. Oek. der Tiere*, XVII, 339) ; II. Ueber die Mortalität und die Variationsbreite tropischer Insekten in Ceylon mit allgemeinen Bemerkungen über die Umweltabhängigkeit und das biologische Optimum (*loc. cit.*, XXII, 287).

(5) Janisch, E. (1932) : The influence of temperature on the life-history of insects (*Trans. Ent. Soc. London*, LXXX, 137).

(6) Janisch, E. (1932) : Ueber die Konstanthaltung von Temperatur und Feuchtigkeit im biologischen Laboratoriums (*Versuch. Abderhaldens Handb. der biol. Arbclitsmethoden*, Abt. V, teil 10).

(7) Janisch, E., und Maercks, H. (1933) : Ueber die Berechnung der Kettenlinie als Ausdruck für die Temperatur-Abhängigkeit von Lebenserscheinungen (*Arb. Biol. Reichsanstalt*, XX, 259).

(8) Janisch, E., und Abdel Aziz Ali Elsayed Ghabn (1933) : Ueber den Einfluss der Luftfeuchtigkeit auf die Entwichlung junger Seidenraupen (*Arb. Biol. Reichsanstalt*, XX, 245).

(9) Janisch, E., Maercks, H. (1933) : Ueber den Einfluss von Temperatur und Luftfeuchtigkeit der Schlupfwespe *Habrobracon juglandis* (*Arb. Biol. Reichsanstalt*, XX, h. 4).

(10) Klemm, Dr. H. (1929) : Beitrag zur Morphologie und Biologie der *Epilachna chrysomelina* Fabr. (Coleopt.) (*Ztschr. f. wiss. Insektenbiol.*, XXIV, 231-262).

(11) Sorauer, P. (1932) : Handbuch der Pflanzenkrankheiten, Fünfter Band. Tierische Schädlinge an Nutzpflanzen, II. Teil, 108.

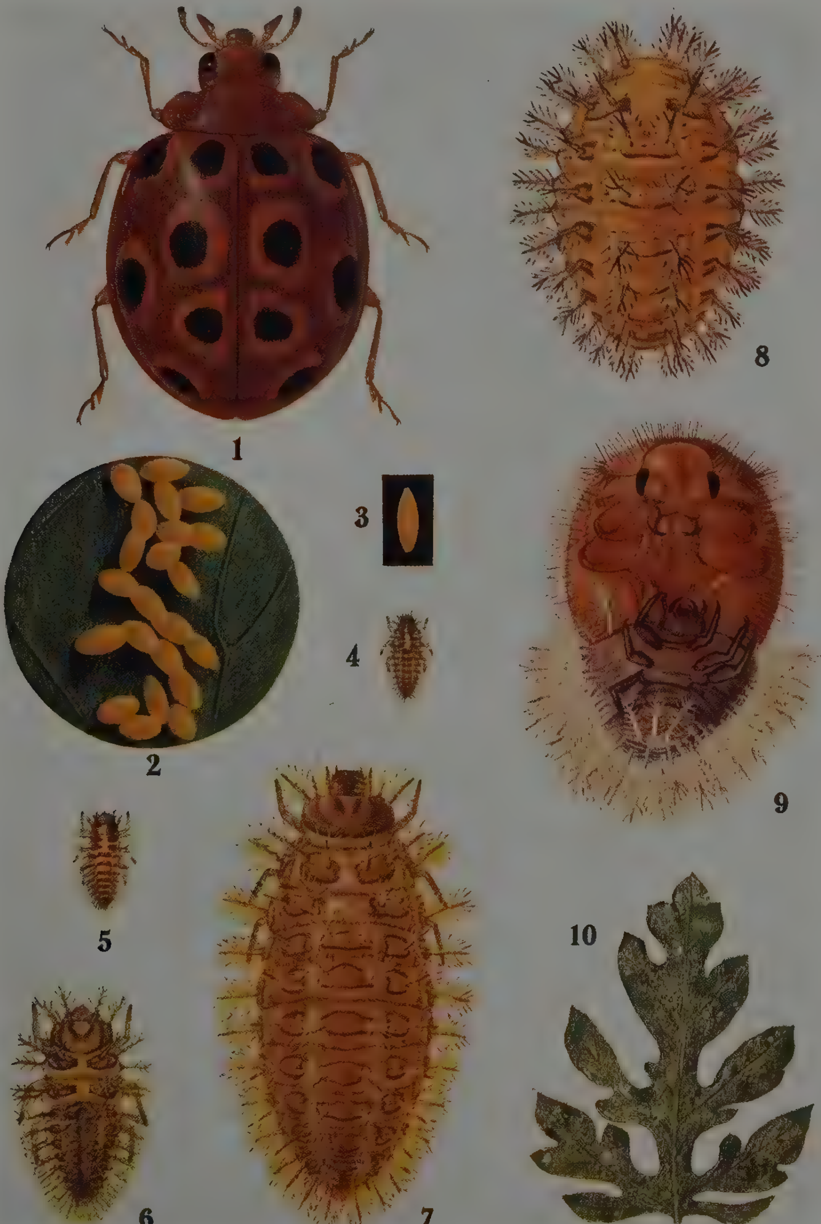
(12) Willcocks, F.C. (1922) : A survey of the more important economic insects and mites of Egypt (Bulletin No. 1, Technical Section, Sultanic Agricultural Society, Cairo, pp. 231-232).

PLATE

Explanation of Plate

Epilachna chrysomelina F.

Fig. 1 : Adult (8.6 × 5.8 mm.).
Fig. 2 : Egg-mass.
Fig. 3 : Egg (1.45 × 0.5 mm.).
Fig. 4 : Larva, first instar (1.75 × 0.6 mm.).
Fig. 5 : Larva, second instar (2.15 × 0.7 mm.).
Fig. 6 : Larva, third instar (4.4 × 1.75 mm.).
Fig. 7 : Larva, fourth instar (9.4 × 3.93 mm.).
Fig. 8 : Larva, fourth instar before moulting to pupa (6.4 × 4.2 mm.).
Fig. 9 : Pupa (5.8 × 4.8 mm.).
Fig. 10 : A leaf of water melon, injured (slightly reduced).



B. Assaad *Pinx*

V. Siviter Smith & Co., Ltd.
Birmingham, England

Notes on the Introduction and Biology of *Microplitis demolitor* Wilk.

[Hymenoptera, Braconidae]

(with 6 Text-Figures, and 5 Tables)

by Mostafa Hafez, B.Sc.,
Parasites Laboratory,
Entomological Section, Ministry of Agriculture (Cairo)

INTRODUCTION

From 1938 to 1941, the Egyptian Ministry of Agriculture employed an Australian entomologist to undertake a study of the status of *Prodenia litura* in Queensland, and the role played by the natural insect enemies in its control in order to assess their value and to introduce into Egypt whichever of them seem promising. This region was selected partly because the population of *Prodenia* never assumes there a high level and because the climatic conditions are similar to those of Egypt. The following are the various parasites which were reared from material collected in Queensland during that period :

Actia nigritula (Tachinidae), *Tritaxys* spec. (Tachinidae), *Paniscus productus* (Ichneumonidae) and *Microplitis demolitor* (Braconidae). Several consignments of *Actia nigritula* and *Microplitis demolitor* were shipped to Egypt between 1939 and 1941. This paper is a brief outline of the biology and behaviour of *Micropolitis demolitor*.

ACKNOWLEDGMENT

The writer wishes to thank Professor Dr. Mohamed Kamal Bey, former chief of the Parasites Researches Laboratory, who was in charge of the introduction of the above parasites into Egypt, for kind help and suggestions.

HISTORICAL

Microplitis demolitor (fig. 1) was described by Wilkinson (1934) from specimens collected at Stanthorpe, Queensland, in 1932. The described specimens were bred from larvae of the Noctuid *Chloridea obsoleta* F. (=*Heliothis armigera* Hubn.) on tobacco. To the writer's knowledge, no reference to the parasite was made in the literature since its description.

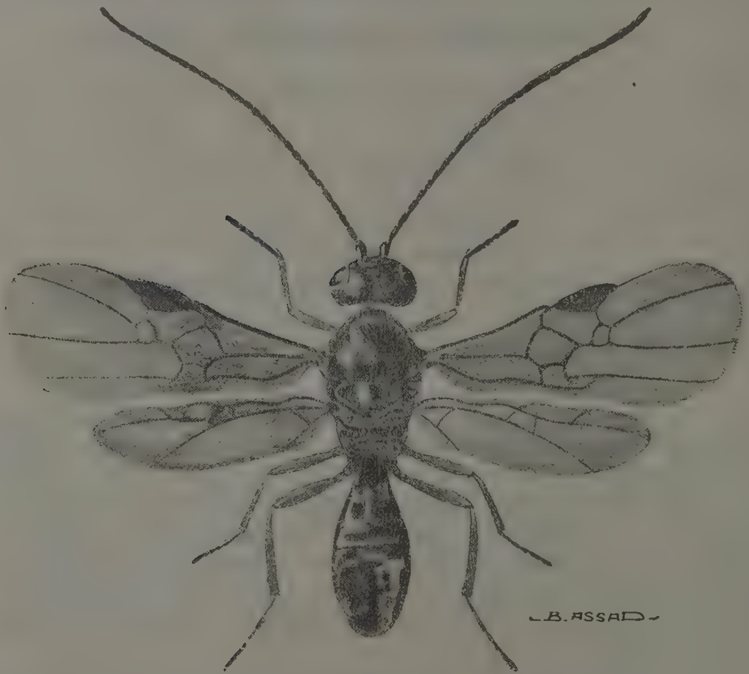


Fig. 1 : *Microplitis demolitor* Wilk., adult male, × 20.

Introduction of Microplitis demolitor into Egypt

Nine consignments of the parasite were received between November 1940 and October 1941.

The parasites were dispatched as newly formed pupae. Most of the adults emerged en route, but a good many of them perished during the journey which took from nine to thirteen days. Of the 953 newly formed pupae which were shipped from Australia, only 684 emerged as adults. Of the latter only 217, 111 females and 106 males, survived the journey. This high percentage of mortality among adults was largely attributed to

excessive humidity within the containers and to the tendency of adults to push themselves through holes in the feeding box whereby they got stuck in the cotton wool soaked with honey solution.

Host preference

Laboratory experiments with larvae of the Noctuids *Prodenia litura*, *Laphygma exigua*, *Agrotis ypsilon* and *Sesamia cretica*, and the Pyralid *Ephestia kuehniella*, have shown that *Microplitis demolitor* would successfully parasitise *Prodenia* and *Laphygma* larvae. It either refuses to oviposit or fail to complete its development on host larvae of the other species.

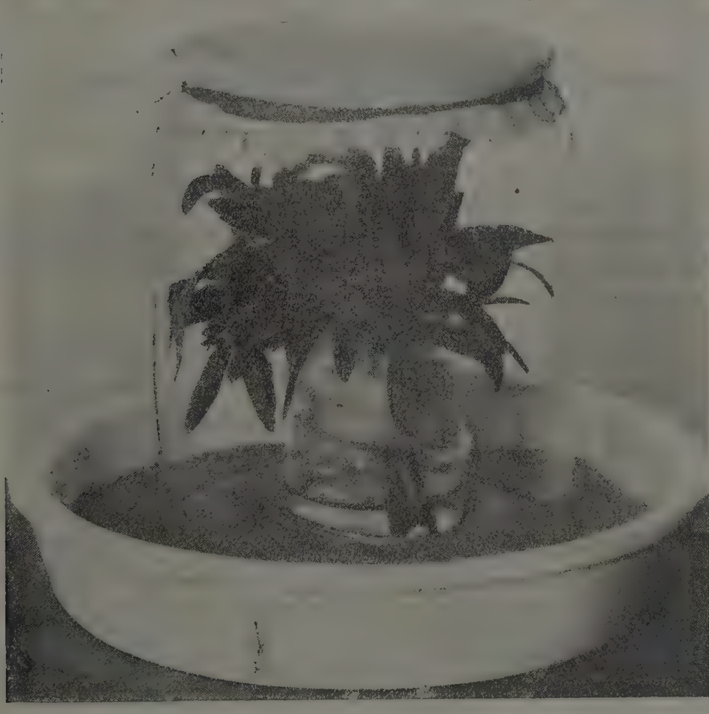


Fig. 2 : The breeding unit of *Microplitis demolitor* Wilk. in the laboratory.

Laboratory breeding

In order to secure a large number of parasites for field liberation, an easy and efficient method of laboratory breeding of both the host and the parasite was devised.

Host rearing

Prodenia litura and *Laphygma exigua* were used as host material for the laboratory breeding of the parasite. The breeding method was the same used by the author (1947) in breeding *Agrotis ypsilon* and *Laphygma exigua*.

Parasite rearing

The parasite breeding unit (fig. 2) consists of a shallow porcelain dish, about 15 cm. in diameter, filled with saw dust. A glass chimney, 12 cm. high and 10 cm. in diameter, pushed to a little depth in the dust, the upper opening of the chimney is covered with muslin cloth kept in position by means of a rubber band. A specimen dish, 3 cm. high and 4 cm. in diameter, filled with water to keep fresh for as long as possible sprigs of corn, cotton or clover which are used as food for the developing host larvae. The water and plants are changed daily. An oleander leaf with droplets of honey scattered on its surface is pinned to the inner surface of the muslin cover to provide food for adult parasites.

From twenty to thirty larvae of *Prodenia* or *Laphygma* are exposed to two to four mated parasite females every twenty four hours. Host larvae are then transferred to breeding cages where they are fed until the parasites have pupated. As soon as parasite cocoons are formed, each cocoon is isolated in a small glass vial about 5 cm. long and 7 mm. in diameter, where emergence takes place.

BIOLOGY

Emergence

When about to emerge, the adult insect pushes up a preformed operculum at one of the ends of the cocoon. The movements of the legs help the insect to make its way out. The life cycle of females is generally slightly longer than that of males, which usually emerge one or two days earlier.

Mating

Since *Microplitis demolitor* is an arrhenotokous species, unfertilised females produce males only, hence copulation plays a most important role in reproduction of the species. Early in laboratory breeding experiments it was realised that mating was not at all satisfactory. Stimuli of various kinds, such as food, sunlight, temperature, different sizes of glass vials, wire-gauge cages, and others, were tried to induce mating, but none of them seemed enough. In consequence with the fact stated by Wigglesworth that the most important stimuli to provide the immediate cause of mating are probably scents, it was suggested that failure of females to attract males migh be due to some kind of odour fatigue suffered by males when

they emerged and stayed with females in the same container. It was thought that if parasites were isolated singly while still in the pupal stage in separate glass vials where they are allowed to emerge, they would mate readily when they met together afterwards.

Parasite cocoons were therefore isolated singly in small glass vials, about 5 cm long and 7 mm. wide. After emergence, adults were classified into male and female groups. Females are readily differentiated by the presence of a minute ovipositor and by their antennae. The latter organ is slightly thinner in females, and about one and one fifth shorter than in

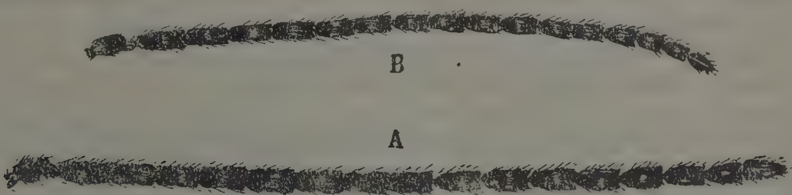


Fig. 3 : Antennae of *Microplitis demolitor* Wilk. : (A) male, (B) female, × 40.

males (fig. 3). Each female was kept in its container for at least half an hour after emergence when one male was introduced to meet her. Within few minutes the parasites were noted to mate.

TABLE I

The sex ratio of the offspring of two groups of females

FEMALES EMERGED	NUMBER OF PROGENY	MALES	FEMALES	PERCENTAGE OF FEMALES
Collectively with males	166	160	6	3.7
Singly in separate glass vials.................	185	80	105	56.8

An experiment was carried out to show the extent of effect of this method on mating. A group of ten males and ten females that had emerged in the same cage were kept together for a period of twenty-four hours. A sufficient number of *Prodenia* larvae were then exposed to them. The sex ratio of the offspring of this group of females was determined and compared with that of the offspring of another group of ten females which were isolated singly in separate glass vials while in the pupal stage. About half an hour after the emergence of each female, one male was introduced into its vial for mating. The results of this experiment are shown in Table I.

This experiment shows that while the sex ratio of the offspring of the first group of females was approximately 4 : 100, it was 57 : 100 in the second group. The results testify to the efficiency of the suggested method in inducing mating and it was therefore employed in the laboratory breeding of the parasite.

The mating process

When the adult male is introduced into the female container, the two insects appear rather excited, moving quickly and vigorously vibrating their antennae. They may meet more than once and touch each other without pairing. Some time later, the male mounts on the female bending the tip of its abdomen ventrally and anteriorly to insert its intromittent organ in the female genital opening. As soon as the insertion is attained, the two insects remain stationary for some time before they separate. Observations made on twenty couples of *M. demolitor* show that the period between the introduction of the male into the female container and the beginning of pairing averages about fifteen minutes, with a maximum of 35 minutes and a minimum of 6 minutes, and that the maximum pairing period is about 53 seconds, while the minimum period is 35 seconds, with an average of 45 seconds. In about one hour after emergence, both males and females can copulate for the first time.

It was noticed that newly mated males attract other males; this is presumably due to the attractive odour of females which sticks to the body of their mates for a while after the copulation process is over. The same phenomenon was also observed by Murr (1930) in a Braconid parasite of the genus *Habrobracon*.

Oviposition

When ready to oviposit, the adult female on meeting its host larva, mounts on it, lifts the posterior part of the body and extends the tip of the abdomen anteriorly between its hind legs. The ovipositor is then extended at right angle with the surface of the host body and is instantaneously thrust into it. When oviposition is completed the parasite soon leaves its host.

It was noticed that most of the parasite eggs are deposited dorsally or laterally in the second and third thoracic and in the anterior abdominal segments. Very often the host larva responds to the movements of the parasite on its body and to the insertion of its ovipositor into it by attempting to dislodge it. Usually, the host larva stands on its abdominal legs, lifts its anterior part, bends its head and thorax posteriorly and excitedly moves it in an attempt to remove the parasite. As the oviposition process is very quick, these movements rarely succeed in preventing ovipositing.

The adult female parasites were not observed to feed on their host body fluids which exude from punctures made by the ovipositor, such as was observed in a considerable number of Braconidae (Clausen, 1940).

Duration of immature stages

The duration of the immature stages varies according to temperature. An experiment was carried out in the laboratory to show the duration of the egg-larval and pupal stages. Table II and Graph (fig. 4) show the minimum and maximum life-cycles in the laboratory at different months of the year.

TABLE II

Minimum and maximum life cycles of Microplitis demolitor *in the laboratory at different months of the year*

MONTH	EGG-LARVAL STAGE IN DAYS		PUPAL STAGE IN DAYS		TOTAL DURATION OF IMMATURE FORMS IN DAYS		AVERAGE TEMPERATURE IN °C	AVERAGE RELATIVE HUMIDITY
	Min.	Max.	Min.	Max.	Min.	Max.		
January	15	18	6	10	21	28	20.5	47.5
February	14	17	5	8	19	25	22	47.5
March	12	14	5	8	17	22	22	51
April	11	12	4	7	15	19	22.5	51.5
May	8	10	3	5	11	15	25.5	47
June	7	8	3	5	10	13	28	49
July	7	8	3	5	10	13	28	52.5
August	8	9	3	5	11	14	27.5	56.5
September	9	10	4	5	13	15	25.5	56
October	10	12	4	6	14	18	23.5	56.5
November	12	13	5	9	19	22	22.5	57
December	15	18	7	10	22	28	20.5	52

This Table shows that under laboratory conditions :

(1) The shortest duration of the egg-larval stage is 7 days in June and July (average temperature 28° C.), while the longest duration is 18 days in December and January (average temperature 20.5° C.).

(2) The shortest duration of the pupal stage is 3 days in summer (May to August, average temperature 27.5° C.), while the longest duration is 10 days in winter (December and January, average temperature 20.5° C.).

(3) The duration of the immature stages varies from 10 days in June and July to 28 days in December and January.

(4) The range of emergence period seems to be inversely correlated with temperature. While this range is 3 days in June and July (average temperature 28° C.), it is 7 days in January (average temperature 20.5° C.).

(5) There is no significant correlation between the duration of the immature stages and the relative humidity in the laboratory.

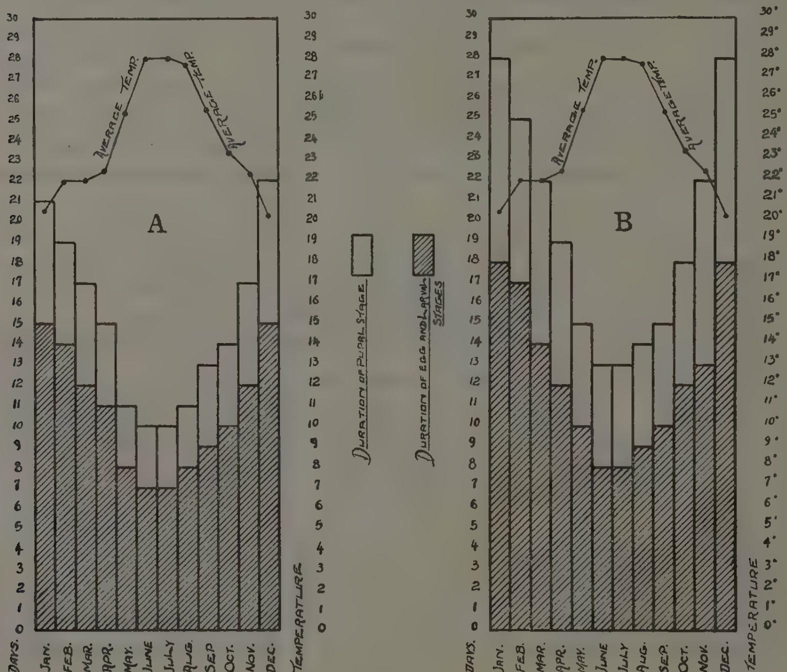


Fig. 4 : Life-cycle of *Microplitis demolitor* Wilk. in the laboratory, at different months of the year, and its relation to temperature : (A) minimum life-cycle in days, (B) maximum life cycle in days.

Longevity of adults

An experiment was carried out to determine the longevity of both males and females of *Microplitis demolitor* under different conditions. Five couples of adults were used in each case. The results of this experiment are shown in Table III.

This Table shows that, under all conditions cited, the average longevity of males is shorter than that of females. It also shows that at 22° C. while the average longevity of adults is about three weeks when honey and water are provided, it is 17 days when only honey is provided and about one week when water only is provided. At 22° C. both sexes survived starvation for an average period of 3 days for males and about one week for females. The average longevity reached its maximum, 55 days for males and 70 days

for females, when adults were kept in ice-box (average temperature 13.5° C.) and provided with honey and water for 20 minutes twice a week in average 22° C. room temperature.

TABLE III

Average longevity of adult males and females

CONDITION OF ADULTS	AVERAGE LONGEVITY		AVERAGE TEMPERATURE IN °C
	♂♂	♀♀	
Kept in laboratory, without food or water	3	7	22
Kept in laboratory, and provided with water	7	8	22
Kept in laboratory, and provided wlth honey	16	18	22
Kept in laboratory, and provided with water and honey	19	23	22
Kept in laboratory, and provided with water and honey for twenty minutes twice a week in room temperature	55	70	13.5

Seasonal history and generations

Microplitis demolitor overwinters as a last instar larva and pupa. The unpublished reports of Miss P. Robertson showed that in Queensland (Australia), cocoons which were collected from the field in June 1940 did not emerge before December of that year, with an average overwintering period of five months.

A number of newly formed cocoons were placed in the field at Giza on November 29th 1941. The first adult emerged on April 4th 1942, while the last did not emerge before April 18th, with an average overwintering period of more than four months. Only 10 per cent of the overwintering pupae, however, survived the winter while 90 per cent failed to emerge.

When newly formed cocoons were kept in the ice-box at a temperature of about 13° C., they all failed to emerge at that temperature. When cocoons stored in the ice-box were transferred to room temperature of about 20° C. at regular intervals, the percentage of emergence decreased with the increase of the storage period. All pupae that were stored in the ice-box for a period of three months failed to emerge after being put in room temperature. The increase in length of the larval and pupal priods during the winter months seems to be due to the decrease in their rate of development brought about by low temperature during these months. Rise in temperature at any stage during this period accelerates development and brings about immediate emergence. The apparent arrested development of the parasite during the winter months is therefore not to be considered a case of diapause. The decrease of the percentage of emergence with the increase in length of low temperature storage period may be due to desiccation of the parasites

or to their starvation by gradual depletion of their stored food material during their storage or due to both factors acting together.

Microplitis demolitor is an uneven hatching species. There is an overlapping of its generations because of the extension of the oviposition period of females. Difficulties of various sorts have hindered the finding of the number of generations of this species in the field. The number of generations per year under laboratory conditions, however, varied from a minimum of 18 to a maximum of 25, with a life cycle varying from 8 to 30 days.

Under field conditions the number of generations per year would be expected to be much less owing to the low temperatures which prevail during the winter months and to the elongation of the time which has to be spent by the parasite in finding its host.

PARASITISM

The parasite female deposits its eggs just under the skin of the host larva. After hatching, the parasite larvae feed on the host body fluids and its fat body. No vital organs, however, are attacked and hence the host larva keeps living until after the parasite has left its body. All the parasite larvae of the same host, with the exception of one larva, perish within the host body. Hence only one parasite larva issues from each host. After leaving its host, the parasite larva begins to spin a cocoon in close proximity of the dying host larva (fig. 5).

The cocoon (fig. 6) is rather spindle in shape with both ends rounded, it is orange yellow in colour and measures from 3-4 mm. in length and from 1-1.5 mm. at its greatest width.

Stages of the host attacked

Prodenia larvae are readily attacked by the parasite at any stage during the first four larval instars. The fifth instar larvae are rarely parasitized while the sixth instar larvae are always successful in showing off the attacking parasites and therefore are never parasitized. It was observed that most parasitized first instar larvae of *Prodenia* fail to tolerate parasitism and that in most cases they progressively weaken and finally die before the parasite larvae have completed their development. Laboratory experiments have also shown that the second and third larval instars of *Prodenia* are the most suitable stages for successful parasitization and that under laboratory conditions *Prodenia* larvae reach this stage after 4 to 5 days in summer and after 5 to 7 days in winter.

Effect of parasitism on host larvae

The effect of the process of oviposition on the host larva was previously described. Few days after oviposition the host larva does not show

any external symptoms, it feeds and moves normally. Gradually, however, it decreases its intake of food until it completely stops feeding one or two days before the parasite larva leaves its body. The parasitized host larva, though continues feeding and moving and moults at exactly the same time

Fig. 5 : The cocoon of *Microplitis demolitor* Wilk. in close proximity of the dying larva of *Prodenia litura* F. (the hole through which the parasite larva has left its host is shown), × 10.

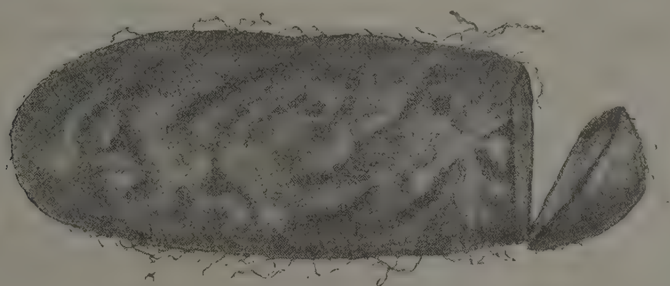


Fig. 6 : Cocoon of *Microplitis demolitor* Wilk. after emergence of the adult, × 20.

as healthy larvae, shows diminution in size. Measurements of parasitized and unparasitized larvae showed that parasitized sixth instar *Prodenia* larvae measured one cm. on the average while unparasitized larvae of the same instar measured four cms. on the average. After the parasite has left its host, the latter keeps alive for only a short period. Table IV shows : (1) the period in days between the time the parasite has left its host and the death of the latter varying from 2 to 8 days in sixty *Prodenia* larvae ; (2) the peak of the mortality of the host is five days after the parasite has left its body.

Attack of parasite larvae and pupae by host larvae

During laboratory breeding experiments it was noticed that some of the parasite cocoons were consumed or partially eaten out and emptied of

their pupae. It was found that these cocoons were attacked and eaten out by :

TABLE IV

Period between issuance of parasite larva and death of host in sixty Prodenia *larvae*

DAYS	NUMBER OF HOST LARVÆ
2	4
3	11
4	12
5	20
6	10
8	3

(1) Unparasitized *Prodenia* larvae which happen to be found in the same cage with parasitized larvae and which attack most of these cocoons.

(2) Parasitized host larvåe before being weakened.

(3) Parasitized host larvae in advanced stages of parasitism which were seen to move slowly towards cocoons of parasites of other hosts and attack them. They were also noticed to bend their anterior portions posteriorly to attack their own parasite cocoons.

It was also noticed that host larvae do not only attack parasite cocoons and pupae but may also attack the parasite larvae immediately after they have left the body of their hosts.

This phenomenon seems to be of less occurence in the field due to the dispersal of host larvae and their infrequent contact with parasite cocoons under field conditions. This does not apply to cases when the host attacks its own parasite.

Factors that hindered the mass production of Microplitis demolitor

Various difficulties have hindered the mass production of *Microplitis* and prevented its production and field liberation in large quantities. The following difficulties are of special significance :

(1) Lack of effective methods of breeding *Prodenia* and *Laphygma*, the most suitable hosts of the parasite, on a large scale to meet the requirements of mass production of the parasite.

(2) Length of the life cycle of these hosts which is about three times as long as that of the parasite.

(3) Susceptibility of these hosts to be attacked by diseases and inability to detect diseased larvae at early stages of infection. This failure results in

exposing seemingly healthy larvae to the parasites and the consequent spread of the disease.

(4) Weakness of laboratory bred host larvae especially during the period of change of seasons in spring, March and April, and in autumn, October and November.

TABLE V

Liberation of Microplitis demolitor *in Egypt*

DATES	NUMBER OF PARASITES LIBERATED	LOCALITIES	HOST PLANTS	HOST INSECTS
4. 5.1941	400	Barrage	Citrus trees	*Prodenia litura*
6. 2.1942	500	Shandawil (Guirga)	Beans, lentil	*Laphygma exigua*
10. 2.1942	1000	Mataana (Qena)	Beans, lentil	,,
16. 4.1942	400	Abshsway (Fayum)	Clover	,,
20. 5.1942	600	Gemmiza (Gharbia)	Lubia	*Prodenia lit·ra*
6. 6.1942	800	Gemmiza (Gharbia)	Lubia	,,
14. 6.1942	1500	Montaza (Alexandria)	Cotton	,,
22. 6.1942	600	Montaza (Alexandria)	Cotton	,,
19.10.1942	300	Kom Bera (Giza)	Clover	,,
TOTAL	6100			

(5) Superparasitism which may result in weakening the host and inadequate feeding of the parasite which either fails to leave its host, fails to spin its cocoon or fails to emerge after spinning the cocoon.

(6) Difficulty of inducing mating under laboratory conditions which was described earlier in a little bit detail. In order to summount this difficulty it is necessary to isolate the parasites during the pupal stage in separate vials, to determine their sex after emergence, and to allow each couple to mate in the female's vial. This method of inducing mating is carried out at great labour.

(7) Host attack of parasite pupae necessitates an examination of the breeding cages at short intervals to remove parasite cocoons before being attacked.

Under those conditions it was very difficult to breed the parasite on a large scale and the numbers liberated in the field were consequently limited. In the writer's opinion the failure of this species to get established in Egypt might be attributed to the inadequacy of field liberations rather than to its failure to adapt itself to Egyptian ecological conditions.

Liberation and recovery of Microplitis demolitor in Egypt

Table V shows the number of parasites liberated at different regions of Egypt in 1941 and 1942. Parasites were examined, fed and induced to

mate before being liberated. Liberations were made in fields infested with appropriate stages of *Prodenia* and *Laphygma* larvae.

In spite of extensive field collections of host insects made since then on different dates at the sites of field liberations of the parasites, no stages of the parasite were recovered. It can be safely said that *Microplitis demolitor* did not become established in Egypt.

SUMMARY

Microplitis demolitor Wilk. was introduced into Egypt from Queensland (Australia), in 1940 and 1941. It is a solitary internal larval parasite of some Noctuids. In Egypt it parasitizes *Prodenia litura* and *Laphygma exigua*. Some notes concerning its biology and behaviour are outlined. The last instar larva leaves its host body and spins a rather spindle shaped orange yellow cocoon in the host proximity. Scent stimulus seems to be the immediate cause of mating under laboratory conditions. Mating was best induced by isolating the parasites, while still in the pupal stage, singly in glass vials where they emerge. Each male was introduced into the female's vial about half an hour after the latter's emergence. Both males and females can copulate for the first time about one hour after their emergence. The average pairing period is about 45 seconds. Oviposition may take place a very short time after emergence. The duration of immature stages varies according to temperature. In the laboratory, the egg-larval stage varied from 7-18 days, and the pupal stage varied from 3-10 days, depending on temperature. Longevity of adults varies according to conditions : it averages about 19 days in males, and 23 days in females when insects are provided with water and honey and stored at about 22° C.. In the laboratory, the number of generations per year varies from 18 to 25 (the number seems to be much less in the field). The parasite overwinters for a period of about four months as last instar larva and pupa within the cocoon. The second and third instar larvae of *Prodenia* seem to be the most suitable stages of the host for successful parasitism. Parasitized larvae die 2 to 8 days after their parasite larvae have left them. Host larvae may attack and feed on last instar larvae, cocoons, and pupae of the parasite.

Several factors were responsible for hampering the mass production of the parasite and consequently very limited numbers were liberated in the field. No recoveries were made from host larvae collected at the sites of field liberations.

LITERATURE CITED

Clausen, C.P. (1940) : Entomophagous Insects (Mc Graw-Hill, New-York and London, 688 pp.).

H a f e z, Mostafa (1947) : The biology and life history of *Apanteles ruficrus* Hal. (*Bull. Soc. Fouad Ier Entom.*, XXXI).

M u r r, L. (1930) : Sexual attraction in *Habrobracon* [Hym.] (*Zeits. Vergl. Physiol.*, II).

W i g g l e s w o r t h, V.B. (1942) : The principles of insect physiology (Methuen & Co. Ltd., London, 434 pages [second edition]).

W i l k i n s o n, D.S. (1934) : On some Microgasterinae [Hym. Brac.] (*Stylops* III, pt. 5, pp. 118-120).

A new Pentatomid from Egypt

[Hemiptera-Heteroptera]

(with 1 Text-Figure)

by R.J. Izzard,
Department of Entomology, British Museum (Natural History)

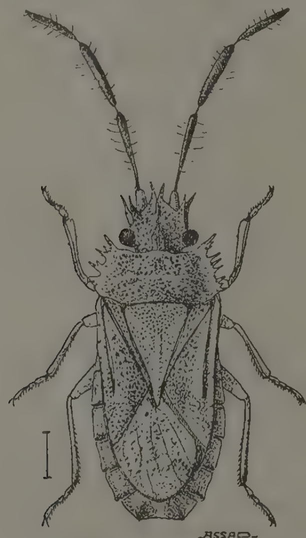
The following description is based on material submitted for identification by Dr. H. Priesner, Ministry of Agriculture, Dokki, Egypt.

Phricodus aegyptiacus sp. n.

Colour : Pale yellow, the head, anterior lobe of pronotum except for lateral processes, base of scutellum, apex of corium, bases and apices of connexival segments and first segment of antennae, pale golden brown; hemielytral membrane white. The whole surface of body except venter densely punctured and covered with short erect scale-like white bristles; lateral denticulate processes of head and pronotum with a few small brown tubercles giving rise to very short brown spines, the costal margin of hemielytra each with six similar brown tubercles evenly spaced; antennal segments 2-4 ferruginous brown with the basal fourth of the second segment pale yellow, the extreme bases and apices of these segments black and the narrow basal stalks of the third and fourth segments black; covered with long pale hairs; eyes reddish; last two segments of rostrum brown.

Structure : Head broadly triangular, eyes prominent, exserted, the facets semi-globular and relatively few in number; vertex convex, lateral margins laminately reflexed forming a long triangular tooth in front of each eye, the apices of juga produced above beyond the apically narrowed tylus in the form of two outwardly curved spurs, and below in two short triangular teeth curving away from base of bucculae; antenniferous tubercle protected by a long spine-like process with thick base arising immediately below front of eye; first antennal segment thickened, widest at middle, second segment gradually thickened from base to apex, third segment fusiform nearly twice as thick in middle as apex of second, fourth segment fusiform about as thick as third; relative lengths of segments 35; 70; 68; 34; ocelli distinct but

placed far back on the head and almost hidden by the anterior margin of the pronotum; rostrum extending to apex of mesonotum, first segment short, extending to a line drawn across middle of eyes, second segment about one third longer than first segment, third segment about one third longer than second. Pronotum hexagonal, the lateral margins explanate, slightly elevated with five tooth-like spines of unequal length, humeral angles each with a



Phricodus aegyptiacus sp. n.

short broad spine. Scutellum long, narrowly triangular, extending beyond clavus, the base swollen and raised at the basal angles with a strongly defined central Y-shaped carina extending to apex. Corium with the lateral margins curved at their base, strongly punctate. Lobe of metasternal orifice prominently auriculate, terminating in a short raised blunt spine. Membrane just reaching apex of abdomen, veins prominent. Femora cylindrical, incrassate; tibiae 4-sided, externally sulcate, pubescent, foretibiae with a tooth-like spine on the inner margin at apex; tarsi with the third segment as long as first and second segments together, pubescent; class reflexed, arolia prominent, divergent.

(♂) length 6 mm., width across humeral angles 3 mm.; (♀) length 7 mm., width across humeral angles 3.5 mm.

Habitat: Egypt, Wadi Gharagid, 24.viii.1925 (leg. M. Kasim), 1 ♂, 1 ♀, Holotype and Allotype (B.M., 1948-584); Wadi Hoff, 4.vi.1928, 1 ♂, 3.viii.1928 (leg. Farag), 1 ♀, Paratype.

Phricodus aegyptiacus fusca var. nov.

There are two specimens which differ only from the typical form by their darker colour, and I therefore propose to name them var. *fusca.*

Habitat : ♂, Wadi Bir Kena, 30.iv.1925, on *Tamarix articulata* (coll. Alfieri); 1 ♀, Ogret El-Sheikh, 12.x.1925 (leg. Farag).

Phricodus aegyptiacus differs from *Phricodus hystrix* Germar in the much paler more uniform colour ; white membrane ; much longer and broader processes of head and lateral margins of pronotum ; shorter whitish scale-like bristles, much less thickened third and fourth antennal segments and with the second antennal segment gradually thickened from base to apex instead of suddenly thickened on apical third as is the case in *P. hystrix* Germ.

Phricodus Spinola 1839, *Rev. Mag. Zool*, 331, has hitherto contained only one species *P. hystrix* Germar (*Aradus hystrix* Germ. 1837, *Silb. Rev. Ent.* V, 134) which is supposedly widely distributed throughout the Ethiopian and Mascarene regions and even occurs in S. India (Bainbrigge Fletcher coll.). However, this species is very variable and it is likely that several subspecies if not species are involved.

Phricodus aegypiacus is the first species of this genus to be recorded from the Palaearctic Region (Eremian subregion). The pale colour is typical of many desert species of Hemiptera and is matched in *P. hystrix* in specimens from S.W. Africa, Okahandja (R.E. Turner coll.). These however, show the typical antennal character of *P. hystrix* and can not be referred to *P. aegyptiacus. P. hystrix* was originally described by Germar (loc. cit.) from the Cape of Good Hope as a species of *Aradus*. Spinola, 1839 (loc. cit.) who established for it the new genus *Phricodus* also regarded it as an Aradid and failed to see the distinct ocelli. Later Westwood 1844, *Proc. Ent. Soc. London*, p. CXIX, and 1847, *Trans. Ent. Soc. London*, IV, 248, redescribed it from Mauritius as a new genus and species, *Stenotoma desjardinsii* and referred it to the Coreidae. Signoret 1849, *Ann. Soc. Ent. France* (2) VII, 327, pl. 9, fig. 3, was the first to place this species in the Pentatomidae (subfamily Pentatominae) between the Old World Sciocorini and the New World Dryptocephalini. He also noticed the resemblance to the Phloeinae.

Stål 1865, Hem. Africana 1, p. 91, placed the genus in the Pentatominae near *Atelocera*, while Kirkaldy 1909, in his Catalogue Hemiptera (Heteroptera), p. 201, also places it in the tribe Halyini. The fact remains that *Phricodus* is a remarkably aberrant Pentatomid although several genera in the Halyini (*Memmia* Stål and *Atelocera* Lap.) possess 4-segmented antennae.

New Hemiptera-Heteroptera from Egypt

(with 3 Text-Figures)

by N.C.E. Miller, F.R.E.S., F.Z.S., F.E.S.S.A.
(Commonwealth Institute of Entomology, London).

The material on which the present paper is based was sent to Dr. W.E. China, British Museum (Natural History), London, by Dr. H. Priesner, Section of Entomology, Ministry of Agriculture, Egypt.

Family REDUVIIDAE.

Sub-family Harpactorinae.

Coranus priesneri sp. n.

Colour : Head and anterior lobe of pronotum black. Posterior lobe of pronotum piceous. Head with a narrow stripe on inner margin of eyes, gula, a narrow stripe laterally in front of eyes, a spot at external margin of each ocellus, a median longitudinal stripe on epicranium not reaching transverse sulcus, juga, external lateral margins of basal segment of rostrum, propleura, except stridulatory furrow and a lateral spot black, yellowish white. Acetabula, propleural epimeron suffused. with brownish white. Collar, anterior lobe with a median stripe and suffusion anteriorly, brownish white. Posterior lobe of pronotum with a suffused brownish white spot laterally anteriorly. Scutellum black with the greater part of median carina, apex luteous. Corium brownish with base of costa whitish. Clavus, area between Cu and claval suture, membrane hyaline, feebly infumate. Abdomen pale testaceous with a suffused stripe basally on each segment dorsally, a suffused spot on connexivum brownish ; ventrally with an irregular piceous stripe sub-laterally. Femora piceous with suffused whitish brown spots : tibiae brownish, pale basally and with a brown sub-basal annulation.

Structure : Head sub-equal in length to pronotum. Basal segment of rostrum extending just beyond anterior margin of eyes. Anterior lobe of pronotum smooth with oblique sulci anteriorly ; posterior lobe strongly rugose with two carinae anteriorly on each side of mid-dorsum. Scutellum trian-

gular, broadly rounded apically; disc not depressed. Head laterally, pleura abundantly setose; legs moderately setose.

Total length, 8.50 mm.; Hemelytra, 5.00 mm.; Greatest pronotal width, 2.50 mm.

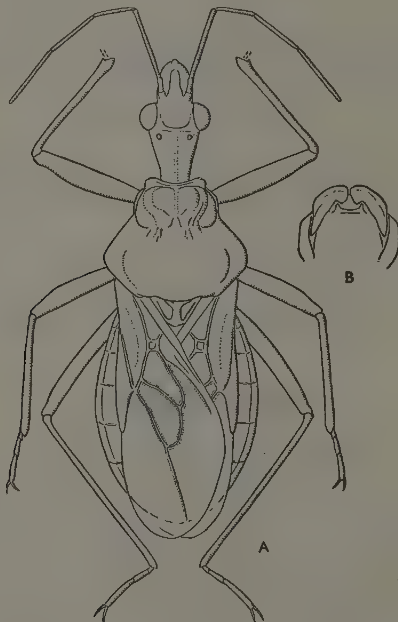


Fig. 1. — *Coranus priesneri* sp.n.: (A) whole insect, dorsal view; (B) Pygophore, dorsal view.

1 ♂ (holotype), Egypt, Gabal Elba, Wadi Aideb, 5.iii.1938, leg. Prof. Priesner (collection of the Ministry of Agriculture).

This new species is apparently allied to *C. niger* Rmb., and *C. tuberculifer* Reut. It differs from both in colouration, smaller size and genitalia apart from other morphological features.

Coranus blanditus sp. n.

Colour: Stramineous. Pleura, abdomen with very faint pinkish suffusion. Vertex and epicranium with a wide longitudinal blackish stripe which divides into two on epicranium; postocular laterally behind eyes with a spot and ventro-laterally with a short stripe dark brown. Anterior lobe of pronotum with dark brown pattern as figured. Scutellum with lateral margins and part of basal depression blackish. Abdomen dorsally with a narrow

black stripe at base of each segment and an irregular black spot at base of connexival segments. Clavus and area between Cu and claval suture hyaline; membrane hyaline, faintly infumate, stramineous. Meso- and metapleura with black suffusion near upper margin. Coxae suffused with black. Anterior femora suffused with brown on upper and outer surfaces; median and posterior femora suffused with brown on inner surface.

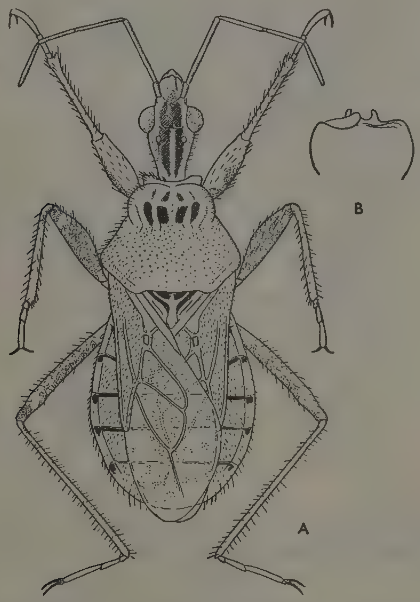


Fig. 2. — ***Coranus blanditus*** sp. n. : (A) Whole insect, dorsal view; (B) Pygophore, terminal view.

Structure : Head sub-equal in length to pronotum. Basal segment of rostrum extending just beyond anterior margin of eyes. Scutellum with apex rounded, feebly produced, erect. Hemelytra extending just beyond apex of abdomen. Head and body with abundant long and short setae. Corium with dense, short curved setae.

Total length, 8.00 mm.; Hemelytra, 5.00 mm.; Greatest pronotal width, 2.40 mm.

1 ♂ (holotype), Egypt, Gabal Elba, Wadi Cansisrob, 27.xii.1938, M. Hussein Selim (collection of the Ministry of Agriculture)

Allied to *C. blandus* Jak., and *C. kiritshenkoi* Berg., from both of which it differs in coloration and in genitalia.

Family ANTHOCORIDAE.

Dokkiocoris gen. nov.

Moderately elongate and somewhat dorso-ventrally compressed. Head wide, not strongly constricted behind eyes. Antennae moderately long, the basal segment not reaching apex of head; remaining segments moderately

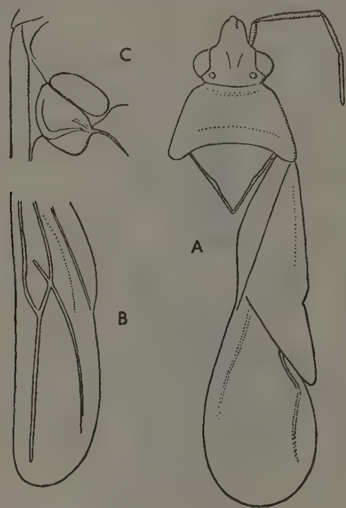


Fig. 3. — *Dokkiocoris bicolor* gen. et sp. n. : (A) Head, pronotum, scutellum and hemelytron, dorsal view; (B) Wing; (C) Meso- and metapleuron.

thick; segment 2 somewhat thicker towards apex, nearly three times as long as 1; apical segments sub-equal in length. Rostrum short, reaching just beyond base of head; basal segment very short; segment 2 about three times as long as 1. Pronotum trapeziform with posterior margin concave and postero-lateral angles rounded; collar obsolete. Scutellum triangular, about as long as wide; disc depressed; sides medially constricted. Venation of membrane, except basal spur indistinct. Anterior femora unarmed.

Genotype the following species :

Dokkicocoris bicolor sp. n.

Colour : Antennae, legs pale stramineous. Anteocular pale yellow; remainder of head brown. Pronotum light brown with dark brown suffusion anteriorly and posterior third dark brown. Scutellum dark brown. Corium pale stramineous, except cuneus, dark brown. Abdomen brown.

Structure : Antennae somewhat densely setose, except basal segment with few very short setae. Pronotum with a shallow, transverse sulcus in basal third.

Total length (♂♂ and ♀♀), 1.70 mm.; Hemelytra (♂♂ and ♀♀), 1.50 mm.

1 ♂ (holo-type), Egypt, El-Miniah, 20.ii.1931, leg. Sabry; 1 ♂, Embaba, 1.i.1930, leg. R. Mabrouk; 1 ♀, Helwan, 5.xii.1931, leg. Farag; 1 ♀, Helwan, 28.xii.1929, leg. Farag; 1 ♀, Helwan, 5.xii.1934, leg. Farag (all on sugar cane). Holotype in the collection of the Ministry of Agriculture, paratypes in the former and in the collection of the British Museum.

In Poppius' key this new genus runs to *Triphleps* but it differs very considerably from it in habitus, the body being somewhat flattened and impunctate also more or less elongate. The basal segment of the antennae does not reach the apex of the head. The rostrum is short, extending only just beyond the base of the head.

12

Description of the Common Egyptian *Trogoderma*

[Coleoptera : Dermestidae]

(with 3 Illustrations)

by Prof. Dr. H. Priesner

Trogoderma afrum spec. nov.

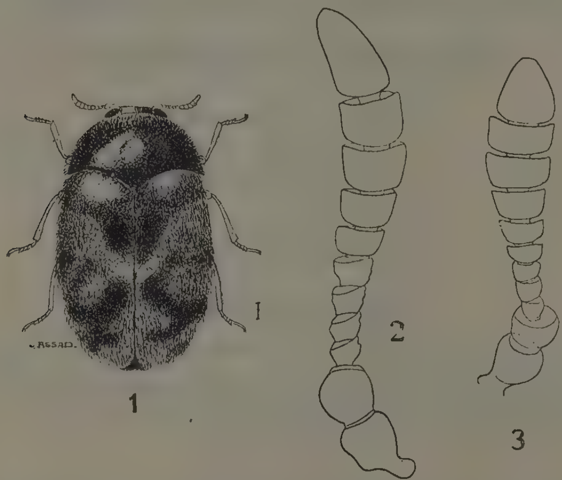
1925. — *Trogoderma versicolor* Willcocks (The insects and related pests of Egypt, II, p. 372, pl. XIX, figs. 7-11).
1934. — *Trogoderma granarium* Zacher (*Mitteil. f. Vorratsschutz*, X, pp. 45, 51).
1935. — *Trogoderma granarium* Zacher (*ibidem*, XI, p. 43).
1935. — *Trogoderma versicolor* Zacher (*ibidem*, XI, p. 82).

Length 1.8-3 mm., breadth 1-1.75 mm.

Sides of body nearly parallel, rounded in front and posteriorly. Surface shining, blackish to (immature specimens) pale brown, head and pronotum in mature specimens always dark; elytra with dark and pale markings. Antennae and legs fulvous to testaceous. Surface clothed with sub-adpressed. yellowish to brown, fine hairs; only a few hairs whitish. All hairs are easily rubbed off. Ventral surface with fine, regularly set, testaceous to light brown hairs.

Head with very punctures, finer than facets of eyes, but somewhat more densely set than in *T. granarium;* middle of head more densely punctured than vertex. Eyes not emarginated interiorly. Antennae in normal specimens 11-segmented; club of male antenna not separated, antennal joints 3-10 transverse (fig. 2); antenna of female much shorter, joints 8-11 more strongly transverse, club 4-5-segmented, ultimate joint shortly oval (fig. 3). Prothorax strongly transverse with lateral margins not visible from above; punctures of disk very fine, widely separated, about as in *granarium;* surface between punctures smooth or, laterally, very feebly rugose. Punctures of elytra much coarser, about as in *granarium*. Epipleura ending, as in *granarium*, about opposite hind margin of metasternal epimeron. Prosternal process with slightly raised lateral margins. Lateral parts

of sternum and abdomen with coarse, shallow and dense punctures. Middle and hind coxae twice as widely separated as front coxae. The female is larger than the male, on an average, and is, apart from the shape of the antenna, distinguished from the male by its regular pilosity of sternite V, which in the latter sex is somewhat more densely pubescent at apical margin.



Trogoderma afrum spec. nov.

Fig. 1 : male. — Fig. 2 : male, right antenna. — Fig. 3 : female, left antenna

Habitat : A major pest of cereals in Egypt and the Sudan. In Upper Egypt it is, according to Rizk Attia, the most important grain pest.

The excellent "Monograph of the beetles associated with stored products," by H.E. Hinton, enabled me to differentiate our common Egyptian *Trogoderma* from the hitherto known species. Hinton gave (t.c., pp. 248-249, and 375-401) exhaustive descriptions of all important species of the genus. From these it appears that *T. variegatum* (Sol.) is distinguished from our Egyptian species by the much more slender antennae of the male, the extremely coarse punctures of the pronotal disk and the alutaceous intervals; the epipleura of the elytra extend beyond hind margin of abdominal sternite I, in *variegatum*. *Trogoderma versicolor* (Creutz.), of which I have examined specimens in the Vienna Museum, differs in having the interior margin of the eye distinctly concave, the male antenna having more strongly transverse joints 3-6, the female antenna, however, less strongly transverse club joints; furthermore, the punctures of the head are coarser and denser.

Trogoderma megatomoides Reitt. has the male antenna not so strongly dilated towards apex, joint 4 distinctly longer than broad, and joints 6 and 7 of the female antenna are much more slender, the club being thus well separated from the rest of the antenna. In *Trogoderma ornatum* (Say) the male antenna is serrate with joints 5-10 triangular in outline, while the female has joints 3-6 nearly globular. The two black species, *Trogoderma glabrum* (Hbst.) and *T. irroratum* Reitt. — the latter being the only other Egyptian species — are much larger insects, having the club joints of the male much more strongly transverse. Our new species comes no doubt closest to *Trogoderma granarium* Everts, of which I received, through the kindness of Rizk Attia Effendi, a large series of specimens from India (leg. K.R. Sontakay). *T. granarium*, similar in size and sculpture, has no distinct pale markings on the elytra, and no defined patches of hairs on them; the intermediate joints of the antennae are much more slender in both sexes, the club being therefore much better separated from the rest; the club is at most 5-segmented, with shortly oval ultimate joint, in the male of *granarium;* in the female of this species joint 7 is only slightly transverse, while in *afrum* joints 7-10 are very broad.

The larva is extremely similar to that of *granarium*, but may be separated by the shape of the antenna which is broader (stouter), on an average, in *granarium*.

Two new Hemiptera-Heteroptera from Egypt

(with 1 Text-Figure)

by Prof. Dr. H. PRIESNER

Family Myodochidae (Lygaeidae)

Stenophthalmicus panici spec. nov.

(Syn. *Stenophthalmicus biskrensis* Lindberg, *Bull. Soc. Fouad I d'Ent.*, 1938, p. 17, fig. 4).

Very similar to, and therefore very easily confused with, *Stenophthalmicus biskrensis* Put.

Pale stramineous, antennae brownish, claws at apex or wholly infuscated. Head as in *biskrensis*, antennae a little shorter, joint 1 surpassing clypeus for only about one-third, in *biskrensis* for one-half of length of segment. Prothorax somewhat less elongate than in *biskrensis*. being in the latter 1.1 times as broad (at base) as long (at middle), in *panici* 1.2 times as broad as long. The pronotum is, near fore margin and in posterior portion, much more sparingly punctured, in *biskrensis* than in *panici*; there are a little more than 30 coarse punctures present in the posterior portion of the pronotum of *biskrensis*, while *panici* has about 60 such punctures on the same part. The whole body is somewhat more slender in *biskrensis* : length of exterior margin of corium measuring 1.5 times greatest width (across hemielytra), in *panici* being only 1.3 times as long as wide. The hemielytra are narrower and shorter in *biskrensis*, not attaining apex of abdomen, while they exactly reach it in *panici*. The rows of punctures — one on clavus, two on the clavus-suture of the corium — are more regular and more densely set in *panici*, while they are finer, scarcer and more irregular in *biskrensis*.

Total body length : 4.5-5.5 mm.

Habitat : I found some specimens (types) near the Pyramids of Giza under *Panicum turgidum*, in November; further specimens were collected by the staff of the Entomological Section of the Ministry of Agriculture, at Mansuriah, from January to March; some others were taken by Mr. Alfieri on the Suez Road, in December and February. All specimens from the desert.

From *Stenophthalmicus hirticornis* Lindbg. the new species differs, like *biskrensis*, by its paler and much less stout antennae. The illustration (fig. 4) given in this Bulletin (p. 17, vol. XXII, 1938), is based on a specimen of *St. panici*, not *biskrensis*. The latter species, a much rarer insect in this country, was formerly considered by me to be a new species. However, Mr. R.J. Izzard, of the British Museum, to whom I sent specimens of the two species, found the slender one identical with *biskrensis*, and determined the species from *Panicum* as new.

Family Tingidae

Tingis (Tropidochila) aegyptiaca spec. nov.

Grey or greyish yellow, with very fine adpressed and curled white pubescence. Antennae either wholly dark or joint 3 yellowish, darker at base. Legs yellow, middle of femora sometimes dark. Head, particularly at sides, densely whitish pubescent. Prothorax and hemielytra greyish yellow,

Tingis (Tropidochila) aegyptiaca spec. nov.

the former at lateral margins towards posterior angles with two to four small black dots. Hemielytra with small black dots on the cross-veins of the marginal area, always with dark spot at the tip of the central area of the corium. Some veins of membrane partly infumated. Pronotal carinae in posterior third each with a black line.

Cephalic spines nearly adpressed. Antennal joint 3 moderately stout, twice or nearly twice as long as joint 1 and 2 combined, joint 4 clavate, about one-half as long as joints 1 and 2 combined. Pronotum little produced at middle, anteriorly, fore margin very slightly concave at both sides of middle; marginal area of pronotum narrow, with one row of cells; carinae of pronotum almost parallel, somewhat convergent anteriorly; punctuation of pronotum coarse only on anterior lobe and on its posterior (scutellar) portion. Median area of corium with coarse punctures, marginal area narrow, with one row of cells throughout. Membrane elongate.

Measurements : Width of head 0.50; antennal joints 1-4 : 0.14, 0.14, 0.47-0.48, 0.24-0.28; pronotum, width 1.13; median area of corium, length 1.56; total length of hemielytron 2.66. Total body length : 3.5-3.6, width 1.23 mm.

Habitat : Egypt, Arabian desert, Wadi Nouega at the northern slopes of the Galala Mountains, 2.v.1925 (female, holotype); Cairo (Abbasiah), 8.vi.1913 (male, allotype). Types in coll. Alfieri.

According to Mr. W.E. China (British Museum, Natural History, London) this insect "comes very close to *Tropidochila geniculata* Fieb., but it is covered with a dense short curled pubescence as described for *pusilla* Jak.; *T. griseola* Put. is described as glabrous except var. *misella* Horv. which is sparsely covered with short setulae".

Neue Wanzenarten aus Aegypten

[Hemiptera-Heteroptera]

(mit 2 Abbildungen)

von EDUARD WAGNER (Hamburg)

1. Orthotylus retamae nov. spec. (Miridae)

Länglich eiförmig (Abb. 1 A + B) : Fühler und Beine verhältnismässig kurz ; Grundfarbe hell weisslichgelb, ohne dunkle Zeichnung, glänzend, mit feiner, gelber Behaarung, zwischen derselben zerstreut schwarze Haare.

Kopf stark geneigt, breiter als hoch, Stirn gewölbt, Stirnschwiele kurz und gekrümmt ; Scheitel beim ♂ 1,5 ×, beim ♀ 2 × so breit wie das kleine, runde, helle Auge ; Hinterrand des Scheitels scharf gerandet. Fühler hell gelblichbraun ; Glied 1 kurz, ,75-0,86 × so lang wie der Scheitel breit ist, oft angedunkelt, vor allem beim ♂ ; Glied 2 stabförmig, beim ♂ etwas dicker als beim ♀, beim ♂ so lang, beim ♀ nur 0,87 × so lang wie das Pronotum hinten breit ist, an Grund und Spitze oft gebräunt ; das 3. Glied 0,7 × so lang wie das 2. (♂, ♀) und 2,5-2,7 × so lang wie des 4. ; die beiden letzten Glieder etwas dunkler.

Pronotum kurz und breit, am Hinterrande 1,40-1,45 × so breit wie der Kopf samt Augen ; Schwielen undeutlich. Schildchen gross, Schildgrund zum Teil unbedeckt. Halbdecken sehr lang, den Hinterleib weit überragend, einfarbig hell : Membran hell rauchgrau, Adern weisslichgelb.

Unterseite und Beine ebenfalls einfarbig hell ; Schenkel schlank, gelblich ; Schienen mit feinen hellen Dornen, Hinterschiene 3,9 × so lang wie der Fuss ; Spitze des 3. Tarsengliedes und Klauen dunkelbraun, 3. Tarsenglied 1,25 × so lang wie das 2. und doppelt so lang wie das 3. Der blassgelbe Schnabel hat eine schwarzbraune Spitze und reicht beim ♂ bis zur Mitte der Mittelbrust, beim ♀ erreicht er die Mittelhüften.

Genitalsegment des ♂ (Abb. 1 H) sehr klein, etwa so dick wie die vorhergehenden Segmente und nur so lang wie die beiden vorletzten zusammen, an der Unterseite nach hinten in einen deutlichen Fortsatz

verlängrt. Linker Genitalgriffel (Abb. 1 C+D) stark gekrümmt, distal spitz, die Hypophysis ist stark gekrümmt und sitzt weit unterhalb der Spitze an einem gleichfalls gekrümmten Arm; Aussenseite des Parameren-körpers mit langen Sinnesborsten. Rechter Griffel (Abb. 1 E+F) kleiner,

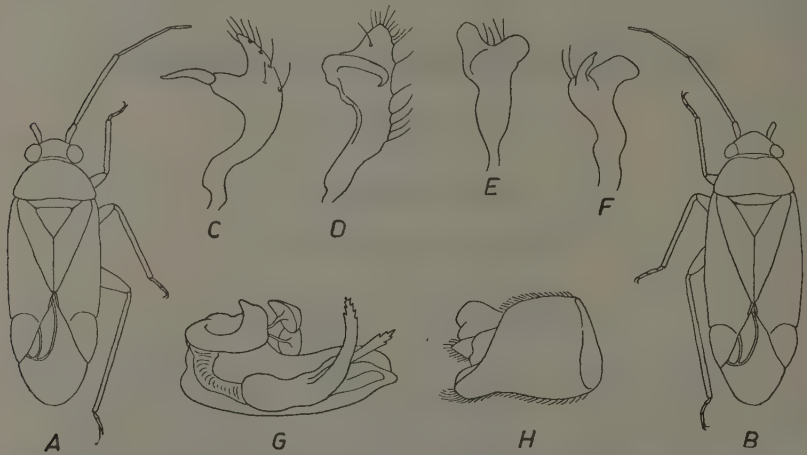


Abb. I : *Orthotylus retamae* nov. spec. : (A) Männchen (18×); (B) Weibchen; (C) linker Genitalgriffel von links (72×); (D) derselbe von innen; (E) rechter Griffel von innen (72×); (F) derselbe von rechts; (G) Penis von links (72×); (H) Genitalsegment des ♂ (27×).

mit 2 ungleichen, gerundeten Fortsätzen; der rechte (die Hypophysis) löffelartig, breit aber flach, seitlich gesehen (F) wie ein Dorn wirkend; neben ihm einige Sinnesborsten. Penis (Abb. 1 G) klein, Theka schlank, Basalteil und Ausatzplatten klein; Vesika mit 2 Chitinbändern, die an der Spitze schwach gezähnt sind.

Länge : ♂=4,2 mm, ♀=4,0-4,4 mm.

O. retamae nov. spec. gehört in die Untergattung *Orthotylus* s.str. und zwar in die *flavosparsus-virescens*-Gruppe. In Grösse und Gestalt ähnelt er *O. lethierryi* Reut., von dem er sich jedoch durch breiteren Scheitel, kleineres Auge, kürzeres 4. Fühlerglied und die einfarbig helle Oberseite unterscheidet. Im Bau der Genitalien ähnelt er am meisten *O. virescens* D.Sc., mit dem er auch die meiste Uebereinstimmung in den übrigen Merkmalen zeigt, und in dessen Nähe er gestellt werden muss. Er ist jedoch von grösserer, breiterer Gestalt, viel heller gefärbt, hat einen längeren Schnabel und viel kürzere Beine und Fühler.

Die Art lebt an *Retama raetam* Webl. Imagines im März.

Ich untersuchte 1 ♂ und 8 ♀♀ aus Aegypten : Suez-Road, 1.iii.36, 1 ♂, 7 ♀♀; Wadi Umm Assad, 18.iii.35, 1 ♀.

Holotype und Paratypoide in der Sammlung H. Priesner, Kairo; Allotypoid und Paratypoide in meiner Sammlung.

2. Cardiastethus pseudococci nov. spec. (Anthocoridae)

Gelbbraun bis braun, mit feiner, kurzer, heller Behaarung; matt.

Kopf glänzend, rotbraun, kurz, nur etwa 0,99× so lang wie mit den Augen breit. Scheitel beim ♂ 1,9×, beim ♀ 2-2,1× so breit wie das schwarze, grob gekörnte Auge; Ocellen braun, vom Hinterrande des Kopfes etwa um ihre doppelte Breite entfernt. Augen vom Vorderrande des Pronotum etwas

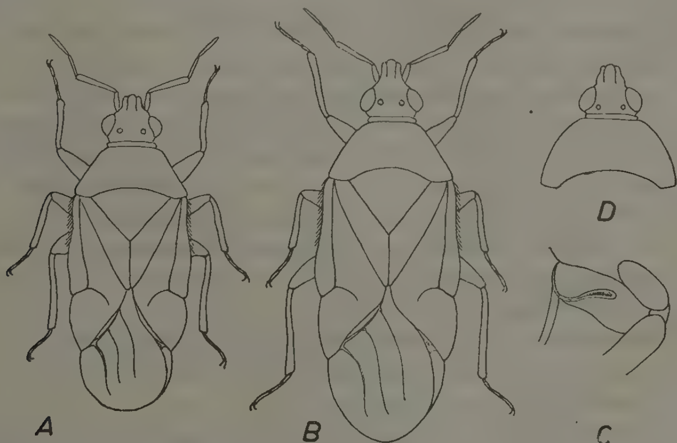


Abb. 2 : *Cardiastethus* ; (A) *C. pseudococci* nov. spec., ♂ (27×); (B) id., ♀; (C) id., Mittelbrust mit Drüsenrinne (72×); (D) Kopf und Pronotum von *C. nazarenus* Reut., ♀ (27×).

entfernt. Fühler gelbbraun, fein hell behaart; Glied 1 etwas länger als das Auge breit ist; Glied 2 gegen die Spitze gleichmässig dicker werdend und dort in der Regel breit dunkel, beim ♂ 1,67×, beim ♀ 1,47× so lang wie der Scheitel breit ist; Glied 3 und 4 dünn, in der Regel dunkler, 3 Glied 0,6× so lang wie das 2. und etwas kürzer als das letzte.

Pronotum trapezförmig, in der Regel dunkelbraun, hinten 2,5× so breit wie vorn und beim ♂ doppelt, beim ♀ 2.1× so breit wie der Kopf samt Augen; Seiten fast gerade (Abb. 2 A+B), Vorderecken kurz gerundet. Schildchen gross, in der Regel dunkel gefärbt, im hinteren Teile grubig vertieft. Halbdecken in der Regel hellgelb, hinterer Teil des Corium und Cuneus dunkelbraun; Aussenrand der Halbdecken in der vorderen Hälfte dicht mit schrägstehenden, weisslichen Haaren besetzt, im hinteren Teile leicht nach aussen gekrümmt. Embolium verdickt, vom Corium durch eine deutliche Rinne getrennt, die sich im hinteren Teile deutlich vom Aussenrande entfernt (Abb. 2 A+B). Membran mit nur 3 erkennbaren Adern, die

ersten beiden schwach und undeutlich, die 3. kräftig, deutlich hervortretend.

Beine einfarbig hell gelblich, fein hell behaart. Der hellgelbe Schnabel erreicht die Spitze der Vorderhüften. Ablaufrinne der Stinkdrüsen (Abb. 2C) von 2 deutlichen Wällen begleitet, die sich allmählich vereinigen, als Kiel am Rande der Pleuren entlanglaufen und den Vorderrand erreichen.

Länge : (♂) 1,8 mm ; (♀) 1,9-2,1 mm.

C. pseudococci nov. spec. ist von den übrigen Arten der Gattung leicht durch die geraden, nach vorn stark konvergierenden Pronotumseiten zu unterscheiden. Von *C. nazarenus* Reut. (Abb. 2D) unterscheidet er sich überdies durch die hellen Schenkel, längeren Kopf, den am Grunde stark behaarten Ausserrand der Halbdecken und vor allem durch das nach hinten stark verbreiterte Embolium ; von *C. fasciiventris* Garb. unterscheidet sich die neue Art durch geringere Grösse, die Form von Pronotum und Embolium und den kürzeren Schnabel. In der Form des Pronotum und der starken Körnelung der Augen ähnelt unsere neue Art *C. ophthalmicus* Reut. aus Columbien, von dem sie sich jedoch durch weit breiteren Scheitel, kleineres Auge, kürzeres 2. Fühlerglied und kürzeren Schnabel unterscheidet.

Die art wurde bei Montaza in Aegypten an Zuckerrohr gefunden, wo sie den Schädling *Pseudococcus sacchari* Ckll. nachstellte. Ich gebe ihr daher den obigen Namen.

Ich untersuchte 1 ♂ und 8 ♀♀ aus Aegypten : Montaza, i.39 (1 ♀), 24.x.39 (1 ♂, 4 ♀♀) ; Meadi, 2.iv.40 (2 ♀♀) ; Cairo, 20.ii.39, unter *Tamarix* (1 ♀) ; sämtlich H. Priesner leg.

Holotype und Paratypoide in der Sammlung der Landwirtschafts-Ministeriums, Kairo ; Allotypoid und Paratypoide in meiner Sammlung.

Neue Miridenarten aus Nordafrika

[Hemiptera-Heteroptera]

EDUARD WAGNER (Hamburg)

Acetropis sinuata nov. spec.

Weibchen : Hell ockergelbbraun, mit bräunlicher Zeichnung und kurzen kräftigen Borsten.

Kopf mehr als halb so breit wie das Pronotum am Hinterrande, kaum breiter als lang, distal stumpf, mit brauner Mittellinie und braunem Seitenstreif vor und hinter dem Auge; der Mittelstreif mit schwarzen Borsten besetzt. Scheitel 3,3 × so breit wie das Auge. Fühler braun; Glied 1 etwas schlanker, mit schwarzen, kurzen Borsten, so lang wie der Kopf breit ist; Glied stabförmig, 3,25 × so lang wie das 1., mit etwas feineren Borsten; Glied 3 so lang wie das 1. und mit den gleichen feinen Borsten wie das 2., schlanker; Glied 4 kaum halb so lang wie das 3., dunkelbraun, die beiden letzten Glieder zusammen weniger als halb so lang wie das 2.

Pronotum am Vorderande ohne Querwulst, mit feinem hellem Mittelkiel, der beiderseits von einem braunen Längsstreif begleitet wird und vorn und hinten undeutlich ist; beiderseits neben dem abgeflachten Seitenrande eine breite braune Längslinie; Seitenrand flach, überall gleich breit, etwas nach oben gebogen; Seiten leicht geschweift, proximal einen deutlichen Winkel bildend. Schildchen einfarbig hell, mit breitem, flachem Längswulst und daneben im hinteren Teile 2 flachen Gruben.

Halbdecken mit kielartigen Adern, fein und dicht punktiert; Membran verkürzt, die Cuneusspitze überragend und mit 2 deutlichen Zellen, die Hinterleibsspitze erreichend.

Beine gelb, mit kräftigen, hellen Borsten; 2.+3. Tarsenglied schwarzbraun bis schwarz. Der Schnabel überragt deutlich die Hinterhüften, sein 1. Glied ist sehr dick und reicht bis zu den Vorderhüften.

Länge : (♀) 6,67 mm., Breite des Pronotum 1,61, des Kopfes, 0,83, des Auges, 0,17; Länge der Fühlerglieder : 1=0,88, 2=2,88, 3=0,86, 4=0,42 mm.

A. sinuata n.sp. steht *A. gimmerthali* Flor sehr nahe und stimmt mit ihr im Fehlen des halsringartigen Querwulstes auf dem Pronotum und in der kurzen, borstenartigen Behaarung überein; die neue Art hat jedoch einen weit deutlicheren Pronotumkiel, geschweifte Pronotumseiten, einen schmaleren Scheitel, weit längeres, schlankeres 1. Fühlerglied, längeres 2. und kürzeres 3.+4. Fühlerglied und längere Beine, deren Borsten hell sind. Von *A. atropis* Reut. unterscheidet sich die neue Art durch den Längskiel des Pronotum, die hellen Fühler und den weit längeren Schnabel. Von *A. carinata* H.S. unterscheidet sich *A. sinuata* n.sp. durch das Fehlen des halsringartigen Querwulstes am Pronotum, die borstenartige Behaarung, die hellen Fühler und den stumpfen Kopf, von *A. longirostris* Put. durch die gleichen Merkmale und den weit kürzeren Schnabel.

Das ♂ ist bisher unbekannt.

1 ♀ aus Spanisch Marokko : Isaguën, vii.46 (Morales leg.), in meiner Sammlung.

Tabelle der Arten von *Acetropis* Fieb.

1 (4) Pronotum am Vorderrande mit halsringartigem Querwulst. 2. Fühlerglied und Schenkel fast kahl.

2 (3 Der Schnabel erreicht das 3. oder 4. Bauchsegment. Mittelkiel des Pronotum fein, nur in der Mitte deutlich. 2. Fühlerglied grösstenteils hell. .... **1. A. longirostris Put.**

5 (6) Der Schnabel überragt kaum den Hinterrand des Mesosternums. Pronotum deutlich. 2. Fühlerglied ganz oder grösstenteils schwarz.... .... **2. A. carinata H.S.**

4 (1) Pronotum am Vorderrande ohne Querwulst. Fühler und Beine in der Regel mit kräftigen Borsten (Ausnahme : *A. atropis* Reut.).

5 (6). Der Schnabel überragt kaum den Hinterrand des Mesosternums. Fühler und Beine fast kahl. Kopf und Pronotum mit schwarzer Zeichnung. Pronotum ohne Mittelkiel. .... **3. A. atropis Reut.**

6 (5) Pronotum zum mindesten hinter den Schwielen mit deutlichem Mittelkiel. Fühler und Beine mit kurzen Borsten. Der Schnabel überragt die Hinterhüften. Zeichnung auf Kopf und Pronotum braun.

7 (8) Mittelkiel des Pronotum deutlich. 1. Fühlerglied so lang wie der Kopf breit ist; das 2. Glied 1,8× so lang wie das Pronotum hinten breit ist. Seiten des Pronotum deutlich geschweift. Scheitel beim ♀ 3,25× so breit wie das Auge. .... **4. A. sinuata nov. spec.**

8 (7) Mittelkiel des Pronotum nur kurz hinter den Schwielen deutlich. 1. Fühlerglied 0,9× so lang wie der Kopf breit ist; das 2. Glied 1,65× so lang wie das Pronotum hinten breit ist. Pronotumseiten gerade. Scheitel beim ♂ 2,5×, beim ♀ 4× so breit wie das Auge. .... **5. A. gimmerthali Flor.**

Solenoxyphus barbatus nov. spec.

Weibchen : Länglich eiförmig, blass weisslichgrün, matt, zerstreut mit krausen weissen Haaren besetzt.

Kopf gelblich, stark geneigt, von vorn gesehen kaum breiter als hoch. Stirnschwiele braun gefleckt, breit, am Grunde stark gekrümmt, dann fast gerade, über dem unteren Augenrande entspringend. Scheitel ungerandet, nur 1,6 × so breit wie das grosse, schwarzbraune, gekörnte Auge. Unterseite des Kopfes mit einem Bart kraftiger, heller Borsten. Stirn oft mit braunen Querlinien, die in der Mitte unterbrochen sind.

Fühler weissgelblich ; Glied 1 angedunkelt, die Spitze des Kopfes etwas überragend, etwas länger als das Auge breit ist ; Glied 2 stabförmig, 2,67 × so lang wie das 1., nur 0,9 × so lang wie der Kopf breit ist und 0.67 × so lang wie das Pronotum hinten breit ist, gegen die Spitze leicht verdunkelt ; Glied 3 schlank, 0,7 × so lang wie das 2. und 1,5 × so lang wie das 4., die beiden letzten Glieder bräunlich.

Pronotum gelblich, trapezförmig, Hinterwinkel gerundet, Pronotum kurz, am Hinterrand 2,7 × so breit wie in der Mitte lang ; Schwielen undeutlich, leicht gebräunt. Schildchen breiter als lang, gewölbt ; Schildgrund zum Teil frei.

Halbdecken weisslichgrün, dicht mit feinen braunen Punkten übersät, die einen kleinen Fleck in der Mitte des Clavus und mehrere kleine Flecke im Corium freilassen. Auch der Cuneus dicht punktiert. Membran milchweiss, ungefleckt, bisweilen mit kaum erkennbarem, verwaschenem, dunklem Längsstreif, der von den Zellen zum Hinterrande führt, auch das distale Ende der Zellen bisweilen etwas dunkler. Adern weissgelb.

Unterseite weisslichgrün, etwas dichter behaart. Beine weissgelblich ; Schenkel nitht verdickt, in der Spitzenhälfte zerstreut braun punktiert : Schienen mit schwarzbraunen oder schwarzen Dornen, die zum grössten Teil aus kleinen braunen Punkten entspringen. Der hellgelbe Schnabel hat eine schwarze Spitze und überragt die Hinterhüften ; sein 1. Glied ist dick und überragt den Hinterrand des Kopfes.

Länge : (♀) 3,1-3,45 mm.

S. barbatus n.sp. ist ein echter *Solenoxyphus*, obgleich er in der hellen Färbung stark mit den Arten der Gattung *Psallopsis* übereinstimmt. Aber die Form des Kopfes, die nicht verdickten Hinterschenkel, die schwarzen Schienendornen und die ungefleckte Membran verweisen die Art in die Gattung *Solenoxyphus*. Von *S. lepidus* Fieb. unterscheidet er sich durch den mit dunklen Punkten bedeckten Cuneus, das Fehlen rötlicher oder brauner Färbung, die dunklen Schienendornen und die helle Membran ; von *S. fuscovenosus* Fieb., dem er am nächsten steht, durch kürzeres 2. Fühlerglied (bei *fuscovenosus* 1,2 × so lang wie der Kopf breit ist und nur wenig

kürzer als das Pronotum hinten breit ist), die dunklen Dornen der Schienen, etwas schmaleren Scheitel, das Fehlen des weissen Mittelstreifs auf Pronotum und Schildchen, die hellen Membranadern und die weisslichgrüne Grundfarbe, von *S. parvulus* Reut. durch grössere Gestalt und die helle Färbung der Membran.

Ich untersuchte 4 ♀♀ aus Aegypten ; Meadi, 26.v.30, H. Priesner leg.

Belegstücke in meiner Sammlung und in der Sammlung H. Priesner.

Vom gleichen Fundort liegen mir 2 ♂♂ einer *Solenoxyphus*-art vor, die Herr Prof. Priesner dort am 23.ii.26 fing (an *Retama raetam*). Sie könnten zu den oben beschriebenen ♀♀ gehören, unterscheiden sich jedoch in einigen Punkten von ihnen. Ich lasse hier ihre Bschreibung folgen und stelle sie vorläufig zu der obigen Art, obgleich ihre Zugehörigkeit nicht erwiesen ist.

Männchen : Länglich eiförmig, blass weissgelblich, dicht mit weissen, krausen Haaren bedeckt.

Kopf gelblich, stark geneigt, braun gefleckt, Stirnschwiele wie beim ♀ gebaut; Scheitel 1,65 × so breit wie das dunkle, grosse, gekönte Auge, sein Hinterrand unscharf. Haare auf der Unterseite des Kopfes nicht auffallend lang. 1. Fühlerglied dunkel, etwas kürzer als das Auge breit ist; Glied 2 etwas länger als der Kopf samt Augen breit ist (1,1 ×) und 0,75 × so lang wie des Pronotum hinten breit ist; 3. + 4. Glied dunkler, zusammen so lang, wie das 2., etwa so lang wie beim ♀.

Pronotum von gleicher Form wie beim ♀, am Hinterrande 2,65 × so breit wie in der Mitte lang, gelblich, mit zerstreuten braunen Punkten. Schildchen und Halbdecken wie beim ♀ ; Membran milchweiss, beide Zellen am Ende und ein Streif, der vom Ende der Zellen zum Hinterrande führt, etwas dunkler.

Beine wie beim ♀, aber die Dornen der Schienen hellbraum bis gelblich. Auch die Unterseite und der Schnabel wie beim ♀.

Länge : (♂) 3,1-3,4 mm.

Der Unterschied in der Behaarung könnte sich daraus erklären, dass die im Mai gefangenen ♀♀ abgerieben waren, wahrend es sich bei den ♂♂ um frischere stücke handelt. Auch bei vielen verwandten Arten hat das ♂ ein längeres 2. Fühlerglied als das ♀. Die hellen Schienendornen dagegen sprechen gegen eine Zusammengehörigkeit mit den oben beschriebenen ♀♀.

Ein neues Miridengenus aus Aegypten

[Hemiptera-Heteroptera]

(mit Abbildungen)

von EDUARD WAGNER, Hamburg

Psallomimus nov. gen.

In der Gestalt sehr stark an manche *Psallus*-arten erinnernd (*P. variabilis*, Fall., *P. ancorifer* Fieb.) ; länglich eiförmig bis länglich, das ♂ kaum schlanker als das ♀.

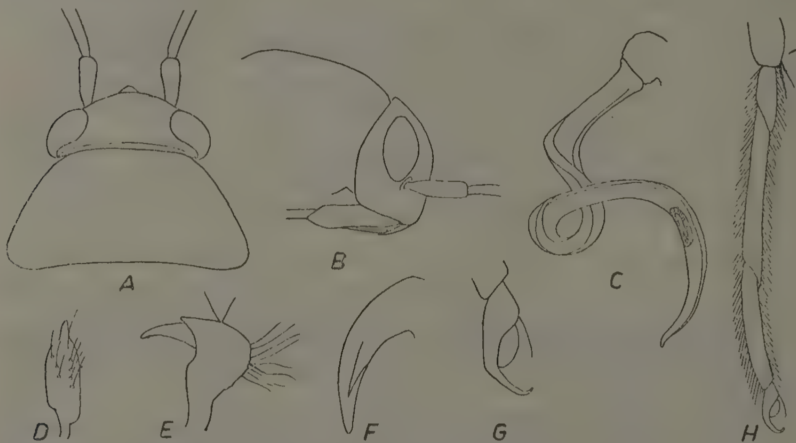
Kopf kurz, stark geneigt (Abb. B) ; Stirnschwiele kaum vorstehend, fast ohne Absatz in die Stirn übergehend, kurz hinter ihrer Basis stumpfwinklig und von da ab etwas nach rückwärts gerichtet, seitlich zusammengedrückt. Kehle sehr kurz. Auge länglich, fein gekörnt und nur wenig vorstehend. Hinterrand des Scheitels mit deulicher Kante. Fühler schlank, Glied 2 stabförmig, nicht verdickt, nahe dem Grunde leicht gekrümmt. Die Fühler entspringen unmittelbar neben der unteren Augenecke.

Pronotum und Halbdecken glatt, glanzend, dicht mit hellen, kräftigen Haaren bedeckt, die ebenfalls glänzen.

Vorder- und Mittelschenkel einfarbig hell, Hinterschenkel schwarz mit gelber Spitze. Schienen einfarbig hell, mit dunklen Dornen, nur am Grunde der Hinterschienen bisweilen einzelne kleine, dunkle Punkte. 3. Tarsenglied weit kürzer als das 2. (Abb. H) ; Klauen (Abb. G) kraftig, bis zur Mitte gerade, dort winklig gebogen und an der Spitze stärker gekrümmt ; Haftläppchen die Mitte der Klau überragend, breit, gerundet, ganz mit den Klauen verwachsen. Schnabel die Spitze der Hinterhüften erreichend ; sein 1. Glied dick, den Hinterrand des Kopfes beträchtlich überragend (Abb. B).

Die Gattung *Psallomimus* nov. gen. gehört zu den *Plagiognathinae* und steht *Phylidea* Reut. am nächsten. Sie stimmt mit ihr überein in der Färbung der Schienen und ihrer Dornen und im Bau der Stirnschwiele, unterscheidet sich aber von ihr durch die Färbung der Schenkel, die bei *Phylidea* sämtlich schwarz sind, durch den hinten scharfkantigen Scheitel, der bei *Phylidea* ungerandet ist, die dichte, helle Behaarung und breitere Gestalt.

In der Gestalt und der Behaarung der Oberseite gleicht sie mehr der Gattung *Psallus* Fieb., von der sie sich jedoch durch die ungefleckten Schienen, die Färbung der Schenkel, den Bau der Stirnschwiele und den hinten gerandeten Scheitel unterscheidet. Im Bau der Genitalien ähnelt sie der Gattung *Phylus*



Psallomimus bicoloripes nov. spec.

(A) Kopf und Pronotum des ♀ von oben (45×); (B) Kopf von der Seite (45×); (C) Vesika des Penis (120×); (D) rechter Genitalgriffel von innen (120×); (E) linker Griffel von links (120×); (F) Theka, seitlich (120×); (G) Klaue des Hinterfusses (240×); (H) Hinterfuss (120×).

Hhn. am meisten. Von allen Gattungen ist sie leicht dadurch zu unterscheiden, dass die Vorder- und Mittelschenkel einfarbig hell, die Hinterschenkel aber schwarz sind und eine gelbe Spitze haben. Auch im Bau der Klauen (Abb. G) steht sie völlig isoliert da.

Psallomimus bicoloripes nov. spec.

Klein, länglich eiförmig (♀) bis länglich (♂), etwas mehr als 3× so lang wie an den Schultern breit. Schwarz, glänzend, oberseits dicht mit krausen, goldglänzenden Haaren bedeckt, die leicht abfallen.

Kopf stark geneigt (Abb. B), kurz, Auge klein, fein gekörnt; Scheitel beim ♂ 1,8×, beim ♀ 2,25× so breit wie das Auge, sein Hinterrand scharfkantig. Fühler zweifarbig; Glied 1 schwarz, kurz und dick, etwa 1,3× so lang wie das Auge breit ist; Glied 2 in der Grundhälfte schwarz, Spitzenhälfte hell gelblich, beim ♂ 3,8×, beim ♀ 3,2× so lang wie das 1., beim ♂ 1,3× so lang, beim ♀ so lang wie der Kopf breit ist und beim ♂ 0,85×, beim ♀ 0,70× so lang wie das Pronotum hinten breit ist, nahe dem Grunde

ist das Glied leicht gekrümmt ; Glied 3+4 hellbraun, dünn, zusammen etwas länger als das 2. ; das 4. etwas mehr als halb so lang wie das 3.

Pronotum kurz und breit (Abb. A) ; Hinterrand kaum eingebuchtet ; Schwielen klein und undeutlich. Schildchen gross, sein Grund frei, Spitzenteil querrunzelig. Halbdecken einfarbig schwarz, Membran schwarzbraun, nur hinter der Cuneusspitze ein kleiner heller Fleck ; Adern schwarzbraun.

Unterseite schwarz, der gelbbraune Schnabel hat eine schwarze Spitze und erreicht das hintere Ende der Hinterhüften. Hüften gelb. Beine gelb, nur die Hinterschenkel mit Ausnahme der Spitze schwarz. Dornen der Schienen dunkelbraun. Schienen ohne schwarze Punkte, nur am Grunde der Hinterschienen entpringen die Dornen bisweilen aus kleinen dunklen Punkten. Tarsen gelblich, mit langen feinen Haaren, das 3. Glied bräunlich ; an den Hintertarsen (Abb. H) ist das 2. Glied fast 3× so lang wie das 1. und 1,4× so lang wie das 3. Die Klauen sind (Abb. G) am Grunde kräftig und fast gerade, distal aber stark verjüngt, in der Mitte fast winklig gebogen und kurz vor der Spitze stark gekrümmt. Die Haftläppchen sind breit, rund, in ihrer ganzen Länge mit den Klauen verwachsen und reichen bis etwas über die Mitte der Klauen hinaus.

Genitalsegment des ♂ schlank kegelförmig, unterseits undeutlich gekielt. Rechter Genitalgriffel (Abb. D) flach, blattartig, schmal, fast parallelseitig, distal plötzlich verjüngt und mit langer, schlanker Hypophysis. Linker Griffel (Abb. E) dick, kopfförmig, mit 2 ungleichen Fortsätzen ; der längere (die Hypophysis) kräftig, leicht abwärts gekrümmt und gleichmässig verjüngt, der kürzere (der Sinneshöcker) kurz, kegelförmig, aufwarts gerichtet ; Aussenseite des Griffels mit langen Haaren. Penis ähnlich der Gattung *Phylus* Hbn., Vesika (Abb. C) sehr lang und stark gewunden, sekundäre Gonopore gross, weit vor der Spitze liegend. Theka (Abb. F) schlank, gleichmässig gekrümmt und verjüngt.

Länge : (♂) 2,9-3,4 mm. ; (♀) 2,8-3,1 mm.

Ich untersuchte 4 ♂♂ und 4 ♀♀ aus Aegypten : Gabal Elba (Wadi Cansisrob), 23.i.33.

Holotypus und Paratypoide in meiner Sammlung, Allotypoid und Paratypoide in der Sammlung des Landwirtschafts-Ministeriums in Cairo.

Einige neue Miridenarten aus Aegypten

[Hemiptera-Heteroptera]

(mit 3 Abbildungen)

EDUARD WAGNER (Hamburg)

I. Habrocoris nov. gen.

Typ. gen. : *H. breviceps* nov. spec.

Zart, mückenähnlich, in der Gestalt der Gattung *Macrolophus* Fieb. ähnlich. Kopf kurz, quer, Augen stark vorspringend, nach vorn ebenso weit vorragend wie die Stirn (Abb. 1B). Kopfseiten hinter dem Auge etwa halb so lang wie das Auge. Fühler lang und schlank (Abb. 1 A). Pronotum trapezförmig, Schwielen undeutlich, hinter ihnen eine deutliche Querfurche. Halsring schmal aber deutlich. Halbdecken den Hinterleib weit überragend, durchscheinend. Hinterleib schlank. Genitalsegment deutlich dicker als die überigen Segmente. Beine lang und auffallend schlank, Tarsen sehr schlank.

Die Gattung *Habrocoris* nov. gen. gehört zu den Dicypharia, unterscheidet sich aber von fast allen Gattungen derselben durch die Form des Kopfes, der vorn fast abgestutzt erscheint (Abb. 1B) ; nur bei der Gattung *Stethoconus* Flor. ist der Kopf in der gleichen Weise gebaut. *Stethoconus* hat jedoch eine weit breitere Gestalt und einen viel dickeren Halsring des Pronotum. In der Gestalt ähnelt sie der Gattung *Macrolophus* Fieb. am stärksten, unterscheidet sich aber von ihr ausser durch die Form des Kopfes durch das Fehlen der schwarzen Zeichnung am Kopf und an den Fühlern. Von *Dicyphus* Fieb. unterscheidet sie sich durch die flachen, undeutlichen Schwielen des Pronotum und von *Campyloneura* Fieb. durch den hinter den Augen verlängerten Kopf. Sie muss ihren Platz im System zwischen *Dicyphus* Fieb. und *Stethoconus* Fl. erhalten.

II. Habrocoris breviceps nov. spec.

Blassgrün, matt, mit feiner, hellgelber Behaarung, nach dem Tode oft gelb werdend. ♂ und ♀ langgestreckt, fast 4 mal so lang wie breit.

Kopf (Abb. 1B) sehr kurz, quer, die Augen stark gewölbt; sie werden nach vorn nur von der Stirnschwiele überragt und sind vom Vorderrand des Pronotum etwa um die Hälfte ihrer Breite entfernt. Scheitel beim ♂ fast 2,5 mal, beim ♀ 2,3 mal so breit wie das Auge. Fühler hell gelbbraun, lang, beim ♀ 1,8 mal so lang wie das Pronotum hinten breit ist; Glied 3 stabförmig, dünn, an der Spitze schmal dunkel, beim ♂ fast doppelt so lang, beim ♀ 1,8 mal so lang wie das Pronotum hinten breit ist; Glied 3 etwa 3/4 so lang wie das 2., dünn; Glied 4 kaum halb so lang wie das 2.

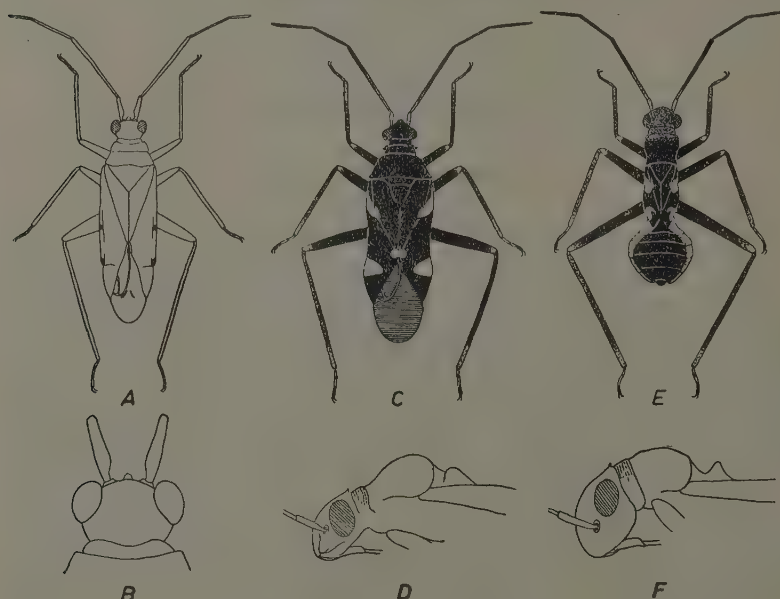


Abb. 1 : *Habrocoris* und *Paramimus* :

(A) *H. brevipes* nov. sp. ♂ (9×); (B) Kopf desselben von oben (28×); (C) *P. quinquemaculius* nov sp., ♂ (9×); (D) Kopf, Pronotum und Schildchen desselben von der Seite (9×).

Pronotum mit schmalem, aber deutlichen Halsring und deutlicher Furche hinter den Schwielen. Die letzteren sind flach und undeutlich. Schildgrund frei, Schildchen gross, fast gleichseitig dreieckig.

Halbdecken durchscheinend, Exocorium hinter der Mitte und an der Spitze in der Regel mit je einem kleinen dunklen (grünen ?) Fleck. Cuneus hell, am Grunde oft ein kleiner, dunkler Fleck. Membran durchscheinend, Adern hellgrün, ausserhalb der grossen Zelle an deren Spitze ein kleiner, grüner Streif.

Beine von Körperfarbe. Schienen mit äusserst feinen, hellen Dornen. Tarsen sehr schlank, das 3 Glied bräunlich. Der blassgrüne Schnabel hat eine helle Spitze und reicht bis zwischen die Hinterhüften.

Länge : (♂) 3,3-3,6 mm. ; (♀) 3,4-3,7 mm.

Ich untersuchte 2 ♂♂ und 2 ♀♀ aus Aegypten : Meadi, 23.v.36 (1 ♀); Saft, 31.viii.30 (1 ♂); Cairo, 12.vi.21 (1 ♂, 1 ♀).

Holotype und Paratypoid in meiner Sammlung; Allotypoid und Paratypoid in der Sammlung des Landwirtschafts-Ministeriums, Kairo.

III. Paramimus nov. gen.

Typ. gen. : *P. quinquemaculatus* nov. spec.

Männchen : Langgestreckt, im Habitus der Gattung *Systellonotus* Fieb. ähnlich. Beine und Antennen auffallend lang und schlank (Abb. 1C). Kopf klein, länger als hoch, gewölbt, Hiterrand des Scheitels scharf gekielt (Abb. 1D). Augen gross, gewölbt, ihr Innenrand fast gerade. 3. Fühlerglied etwa halb so lang wie das 2., das 4. etwas länger als das 3. und die beiden Endglieder zusammen kaum länger als das 2.; letzteres stabförmig, nicht verdickt. Pronotum stark gewölbt, mit breitem Halsring. Hinterer Teil des Schildchens buckelartig gewölbt (Abb. 1D). Halbdecken die Hinterleibsspitze weit überragend, dunkel mit weissen Flecken. Schenkel und Schienen sehr lang, stabförmig, rund. 2. Glied der Hintertarsen viel länger als das 1.

Weibchen : Sehr schlank, stark ameisenähnlich (Abb. 1E). Fühler und Beine wie beim ♂ sehr lang und dünn. Kopf breiter als das Pronotum, stark geneigt, sehr lang. Augen flach, ihr Innenrand fast gerade. 3. Fühlerglied 0,67 × so lang wie das 2. und etwa so lang wie das 4. Glied. Pronotum mit breitem Halsring. Hinterer Teil des Schildchens mit aufrechtem Zapfen (Abb. 1F). Halbdecken stark verkürzt. Hinterleib am Grunde stark eingeschnürt, im hinteren Teile kugelig erweitert. 2. Glied der Hintertarsen viel länger als das 1.

Die Gattung *Paramimus* nov. gen. gehört zu den Systellonotinae und muss in die Nähe von *Mimocoris* Scott gestellt werden, mit dem sie in dem gekielten Hinterrand des Scheitels übereinstimmt, von dem sie sich aber durch das schlanke, stabförmige 2. Fühlerglied, die schlanke Gestalt, die langen Beine und die Zeichnung der Halbdecken unterscheidet. Von *Hypomimus* Lindbg. unterscheidet sie sich durch die gleichen Merkmale, vor allem aber durch die dünnen Antennenglieder, von *Systellonotus* Fieb., dem sie in der Gestalt sehr ähnelt, durch das weit kürzere 3. Fühlerglied und den gekielten Hinterrand des Scheitels, von *Allodapus* Fieb. durch den starken Sexualdimorphismus, die weit schlankere Gestalt und die Zeichnung der Halbdecken.

IV. Paramimus quinquemaculatus nov. spec.

Männchen : Schlank, zart, schwarzbraun bis schwarz, glänzend, zerstreut mit feinen, hellen Haaren bedeckt.

Hopf klein, geneigt, seitlich gesehen (Abb. 1D) etwa 1,5 mal so lang wie hoch ; Hinterrand des Scheitels scharf gekielt, Scheitel 1,8 mal so breit wie das runde, grobgekörnte, helle Auge. Fühler sehr lang und schlank, braun ; Glied 1 weisslich gelb, so lang wie der Scheitel breit ist ; Glied 2 sehr lang und dünn, stabförmig, 2,1 mal so lang wie das Pronotum breit ist, am Grunde heller ; Glied 3 kaum dünner als das 2. und 0,55 mal so lang wie dasselbe ; Glied 4 etwas länger als das 3.

Pronotum stark gewölbt (Abb. 1D), fein und dicht punktiert, Halsring breit, mit deutlichen Querrillen ; Schwielen undeutlich. Schildchen gross, Schildgrund frei, nach hinten geneigt, hinterer Teil des Schildchens stark buckelartig gewölbt. Halbdecken schwarzbraun mit 5 weissen Makeln : 2 schrägstehende Flecken, die nahe dem Grunde des Aussenrandes entspringen und zur Mitte der Clavusnaht führen und dort noch etwas auf den Clavus übertreten, 2 dreieckige, querliegende Flecken am Coriumende, die den Innenrand nicht erreichen ; der 5. Fleck liegt in der Mitte des Corium neben der Clavusspitze und tritt ein wenig auf diese über ; er besteht aus zwei aneinanderliegenden Kreisen (Abb. 1C). Cuneus einfarbig schwarzbraun. Membran schwarzgrau, Adern graubraun. Unterseite schwarz, glänzend. Hinterleib sehr lang und schlank, bis zur Mitte des Cuneus reichend. Beine schwarzbraun : Schenkel sehr lang, stabförmig, mit heller Spitze ; Schienen sehr dünn und lang, im Spitzenteil aufgehellt ; Tarsen graugelblich, das 1. Glied nur 0,6 mal so lang wie das 2. und etwas kürzer als das 3. Glied.

Weibchen : Ameisenähnlich, schlank (Abb. 1E), schwarzbraun, glänzend, Halbdecken mit aufrechten, hellen Haaren. Bisher nur brachypter.

Kopf rotbraun, matt, grösser als beim ♂, flach, von vorn gesehen länglich dreieckig, seitlich gesehen viel länger als hoch (Abb. 1F) ; Hinterrand des Scheitels scharf gekielt ; Scheitel 3,2 × so breit wie das grosse, flache Auge. Fühler lang und schlank ; Glied 1 weisslichgelb, 0,63 × so lang wie der Scheitel breit ist ; Glied 2 dünn, stabförmig, schwarzbraun, doppelt so lang wie das Pronotum breit ist ; Glied 3 am Grunde etwas heller, 0,67 × so lang wie das 2. und etwa so lang wie das 4.

Pronotum schwarzbraun, glänzend, im vorderen Teile heller, stark gewölbt, hinten etwas schmaler als vorn. Schildchen klein, im hinteren Teile ein kegelförmiger, aufrechter Zapfen (Abb. 1F). Halbdecken verkürzt, schmal, bis zum Ende des 3. Hinterleibssegmentes reichend, schwarzbraun, Corium mit 2 weissen Fleckenpaaren, von denen das vordere etwas auf den Clavus übertritt ; der 5. Fleck (an der Clavusspitze) fehlt beim ♀.

Hinterleib schwarz, glänzend; 1.+2. Segment stark eingeschnürt (Ameisentaille), die übrigen Segmente fast kugelig erweitert (Abb. 1E); Connexivum nach oben umgelegt, der umgelegte Rand weissgelblich. Unterseite des Abdomens in der proximalen Hälfte schmutzig weissgelb. Beine wie beim ♂.

Länge : (♂) 3,8-4,0 mm.; (♀) 3,3-3,6 mm.

Grössenverhältnisse

	LÄNGE	BREITE DES				LÄNGE VON FÜHLERGLIED			
		PRONOTUM	KOPFES	SCHEITELS	AUGES	1	2	3	4
♂	391	96	63	30	16,5	30	132	73	83
♀	340	56	67	41	13	25	109	72,5	62 ?
Alle Masse in 1/100 Millimetern.									

Ich untersuchte 4 ♂♂ und 2 ♀♀ aus Aegypten ; Rotes Meer, 18.+20.i.33, und Halaib 20.i.33 (H. Priesner leg.).

Holotypus und Paratypoide in meiner Sammlung; Allotypoid und Paratypoide in der Sammlung des Landwirtschafts-Ministeriums, Kairo.

V. Orthotylus (Halocapsus) hirtulus nov. spec.

Eiförmig, das ♂ schlanker als das ♀ (Abb. 2 A+B), schwach glänzend, oberseits und unterseits mit etwas krausen, weisslichen Haaren, die büschelweise stehen und dazwischen zerstreuten schwarzen, glatten Haaren; unterseits sind die schwarzen Haare zahlreicher. Grundfarbe blassgrün, teilweise auch gelblich.

Kopf stark geneigt, kurz, gelblich, Stirnschwiele stark gekrümmt. Scheitel beim ♂ 1,9 mal, beim ♀ 2,5 mal so breit wie das fast kugelige, schwarze Auge. Fühler hell gelblich; Glied 1 dick, etwa so lang wie das Auge; Glied 2 stabförmig, beim ♂ dick, beim ♀ schlank, etwas kürzer als der Hinterrand des Pronotum und etwas länger (♀) oder so lang (♂) wie die beiden letzten Glieder zusammen; Glied 3 beim ♂ 2,5 mal, beim ♀ 2,6 mal so lang wie das 4.

Pronotum kurz, trapezförmig, sehr breit, gelblich; Schwielen undeutlich Schildchen gelblich, Schildgrund bedeckt.

Halbdecken grünlich, am Aussenrand etwas dunkler, Aussenrand beim ♂ schwarz, beim ♀ stark gerundet. Membran den Hinterleib weit überragend, hell rauchgraubraun, Adern gelbbraun. Hinterleib bei beiden

Geschlechtern auffällig kurz. Der kräftige gelbbraune Schnabel hat eine schwarze Spitze und überragt die Hinterhüften deutlich.

Beine gelbbraun, Schenkel kräftig, vor allem die Hinterschenkel, Schienen mit kräftigen hellen Dornen.

Genitalsegment des ♂ kleiner als die vorangehenden Segmente. Linker Griffel (Abb. 2C) distal stark verbreitert, Hypophysis lang und spitz, nach innen gerichtet, stark gekrümmt. Rechter Griffel (Abb. 2D) keulenförmig, distal aussen mit zahlreichen langen Borsten und nach innen gerichteter, kurzer, kräftiger Hypophysis. Penis (Abb. 2 E+F) sehr einfach gebaut, schlank und spitz; Vesika mit 2 glatten Chitinbändern; Spitze der Theka mit zwei ungleichen Blättern.

Länge: (♂) 3,3-4,1 mm.; (♀) 3,4-3,8 mm.

Grössenverhältnisse

	LÄNGE	BREITE DES				LÄNGE VON FÜHLERGLIED			
		PRONOTUM	KOPFES	SCHEITELS	AUGES	1	2	3	4
♂	385	122	88	42	23	22	106	78	29
♀	356	124	90	50	20	25	113	73	30
Alle Masse in 1/100 Millimetern. Alle Messungen senkrecht von oben.									

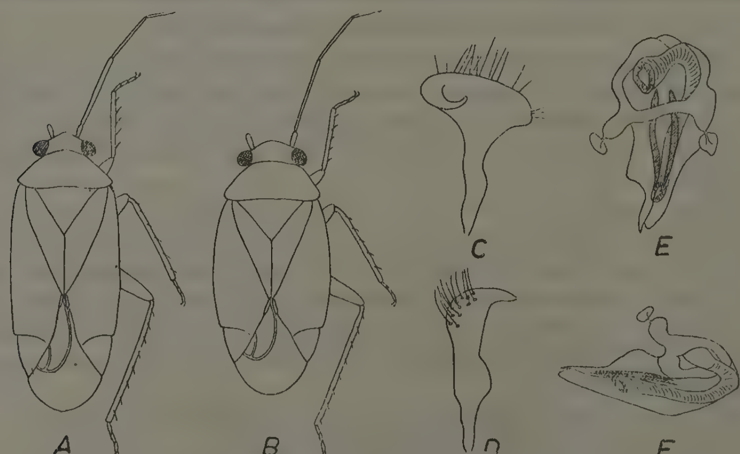


Abb. 2: *Orthotylus (Halocapsus) hirtulus* nov. spec.:

(A) Männchen (12.5×); (B) Weibchen (12.5×); (C) linker Genitalgriffel von innen (84×); (D) rechter Genitalgriffel von rechts (84×); (E) Penis von oben (96×); (F) derselbe von links (84×).

Halocapsus hirtulus nov. sp. steht *H. palustris* Reut. am nächsten, unterscheidet sich aber von ihm durch die grössere, breitere Gestalt, die büschelige, helle Behaarung, die Längen der Fühlerglieder, die Breite des Scheitels, das schwarze kugelige Auge und den Bau der Genitalien, vor allem des linken Griffels. Auch von den übrigen Arten der Untergattung ist er leicht durch seine Grösse, seine auffallende Behaarung und die schwarzen Augen zu trennen.

Aufenthalts-Pflanze unbekannt. Imagines von September-November.

Ich untersuchte 9 ♂♂ und 7 ♀♀ aus Aegypten (Meadi, Turra, Strasse nach Suez).

Holotype und Paratypoide in meiner Sammlung; Allotypoid und Paratypoide in der Sammlung der Landwistschaftsministerium, in Kairo.

VI. Psallus deserticola nov. spec.

Breit eiförmig, das ♂ etwas schlanker als das ♀ (Abb. 3 A+B), oberseits dicht mit goldglänzenden Haaren bedeckt, die leicht abgerieben werden. Grundfarbe weisslichgelb, auf Kopf, Pronotum, Schildchen und Halbdecken oft mit schwarzbrauner Zeichnung von wechselnder Ausdehnung.

Kopf kurz, gewölbt, stark geneigt, einfarbig hell, nur die Stirnschwiele zum grössten Teile und die Fühlerwurzel braun. Scheitel ungerandet, beim ♂ 2,1 mal, beim ♀ 2,4 mal so breit wie das grobgekörnte, dunkle Auge. Fühler weisslichgelb; Glied 1 schwarzbraun, mit heller Spitze, etwa so lang wie das Auge breit ist; Glied 2 stabförmig, beim ♂ dicker als beim ♀ und etwa 0,7 mal so lang wie das Pronotum breit ist; Glied 3 dünn, 0,6 mal so lang wie das 2.; Glied 4 nur 0,7 mal so lang wie das 3., die beiden Endglieder etwas dunkler.

Pronotum breit und kurz, etwa 1,5 mal so breit wie der Kopf samt Augen; wechselnd gefärbt, bald einfarbig hell, bald einfarbig dunkelbraun oder im hinteren Teile braun. Schildchen beim ♀ hell, beim ♂ dunkel. Halbdecken am Coriumhinterrand mit dunkelbrauner Querbinde. Spitze des Cuneus breit dunkel, seine Fläche bisweilen zum Teil rötlich. Membran dunkel rauchgrau, Adern weisslich; die Spitze beider Zellen und ein Streif hinter denselben schwärzlich, hinter der Cuneusspitze und in der Mitte des Seitenrandes je ein glasheller Fleck.

Unterseite hell. Der helle Schnabel hat eine schwarze Spitze und überragt die Hinterhüften deutlich.

Beine hell lehmgelb; Schenkel vor der Spitze mit zahlreichen schwarzen Flecken von unterschiedlicher Grösse, Hinterschenkel oberseits überdies angedunkelt; Schienen mit feinen Dornen, die aus schwarzen Punkten entspringen; Tarsen schlank, hell, nur die Spitze des 3. Gliedes dunkel Das 2. Glied der Hintertarsen deutlich länger als das 3.

Genitalsegment des ♂ unten schwach gekielt. Linker Genitalgriffel (Abb. 3D) mit langer, im Spitzenteil gerader Hypophysis, auf dem Sinneshöcker ein kurzer, schlanker Zapfen; Paramerenkörper distal an der

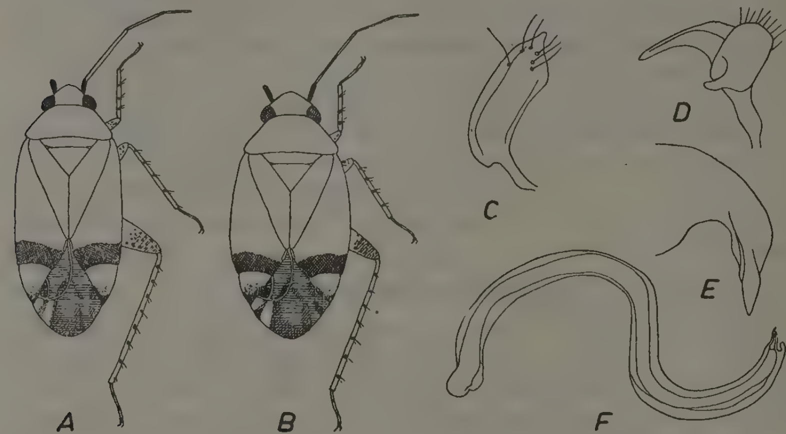


Abb. 3 : *Psallus deserticola* nov. spec.:

(A) Männchen (12,5×); (B) Weibchen (12,5×); (C) rechter Genitalgriffel von innen (84×); (D) linker Genitalgriffel von links (84×); (E) Theka (84×); (F) Vesika des Penis (84×).

Aussenseite fein behaart. Rechter Griffel (Abb. 3C) blattartig flach, leicht gewölbt, fast parallelseitig, Hypophysis kurz und kräftig; Paramerenkörper distal mit 6-8 schwachen Borsten. Penis kräftig, Vesika (Abb. 3F) S-förmig gekrümmt, distal mit 1 Spitzen, von denen die längere aus 2 Blättern besteht. Theka (Abb. 3E) distal stark zugespitzt, proximal stark gekrümmt.

Länge: (♂) 3,1-3,5 mm.; (♀) 2,9-3,6 mm.

Grössenverhältnisse

	LÄNGE	BREITE DES				LÄNGE VON FÜHLERGLIED			
		PRONOTUM	KOPFES	SCHEITELS	AUGES	1	2	3	4
♂	323	124	82	42	20	18	87	53	35
♀	323	126	81	45	18	19	90	56	35
Alle Masse in 1/100 Millimetern. Alle Messungen senkrecht von oben.									

P. desrticola nov. spec. gehört in die Gruppe der Arten, deren Membran ausser dem hellen Fleck an der Cuneusspitze noch seitlich am Aussenrande einen weiteren hellen Fleck trägt. Er steht *P. puncticollis* Fieb. am nächsten, unterscheidet sich aber von ihm durch hellere Grundfarbe, kürzeres 2. Fühlerglied, kleineres Auge und viel breiteren Scheitel. Von *P. ericoroides* Reut. ist die Art leicht durch die helle Färbung, den breiten Scheitel, das kürzere, einfarbig helle 2. Fühlerglied und die Zeichnung der Halbdecken zu trennen.

Ich untersuchte 4 ♂♂ und 3 ♀♀ aus Aegypten : Wadi Umm Assad, 14.x.39 ; Wadi Digla, 26.ix.33, und Meadi, 23.ix.33, H. Priesner leg.

Holotype und Paratypoid in meiner Sammlung; Allotypoid und Paratypoide in der Sammlung H. Priesner, Kairo.

h

Aethus macrophthalmus nov. spec., eine neue Cydnidenart aus Aegypten

[Hemiptera-Heteroptera]

(mit Abbildungen)

von Eduard Wagner (Hamburg)

Eiförmig, gewölbt, schwarz, glänzend. Ränder von Kopf, Pronotum und Halbdecken dicht mit sehr langen, feinen, hellbraunen Haaren besetzt.

K o p f kurz und breit, Aussenrand der Wangen zwischen den langen Haaren mit kurzen kräftigen Dornen. Scheitel nur 2,5-2,6 mal so breit wie das grosse, grob gekörnte Auge, das seitlich weit über die Wangen vorspringt. Ocellen rotbraun, gross, von den Augen um wenig mehr als die Breite der Ocelle entfernt. Stirnschwiele nach vorn stark verjüngt, fast eingeschlossen. Fühler kurz, kräftig, schwarzbraun, fein hell behaart, die Glieder etwa gleich lang, nur das 2. und 4. Glied sind etwas länger; Glied 3 an der Spitze, Glied 4 mit Ausnahme des Grundes und Glied 5 ganz gelbbraun.

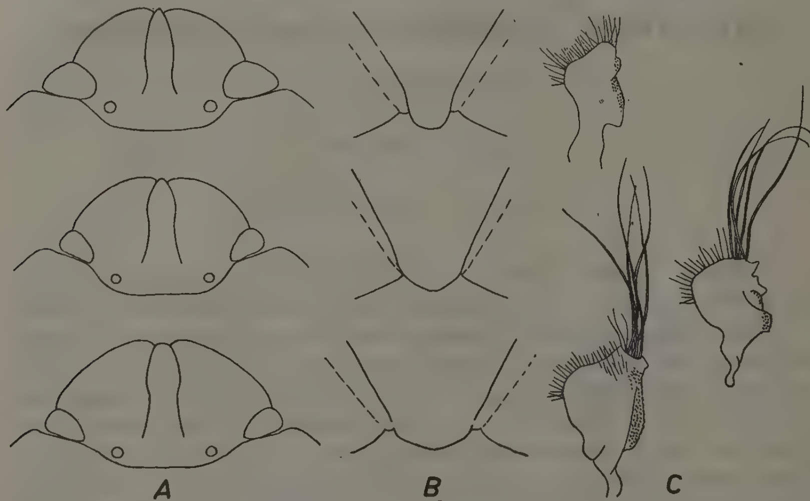
P r o n o t u m breit, Seitenränder nach vorn konvergierend, Vorderecken stark gerundet. Fläche des Pronotum glatt, glänzend, nur hinter dem Vorderrand, neben den Seiten und eine Querzone im hinteren Teile fein punktiert. Schildchen zerstreut grob punktiert. Schildspitze (Abb. B) recht schmal, gleichmässig gerundet; Seiten vor der Spitze stark geschweift. Halbdecken fein punktiert, neben den Nähten kräftige Punktreihen. Membran weisslich. Unterseite glatt.

B e i n e schwarzbraun, glänzend, Schienen stark bedornt in der für die Gattung charakteristischen Weise. Tarsen gelbrot.

G e n i t a l s e g m e n t des ♂ schmaler und länger als bei den verwandten Arten, mit fast geraden Seiten und leicht nach aussen gebogenem Hinterrand. Genitalgriffel (Abb. C) klein, der Paramerenkörper viel länger als breit, distal schmal abgerundet, aussen fast winklig vorspringend, an der Innenseite distal mit rund vorstehendem Lappen, proximal kinnartig nach unten verlängert, obere Aussenkante dicht mit Haaren besetzt, die auch

an der Spitze nur so lang sind wie an der übrigen Aussenkante und stets weit kürzer sind als der Griffel.

Bei *A. pilosus* und *A. hispidulus* ist der Paramerenkörper viel breiter, anders geformt und trägt an der Spitze 5-6 auffallend lange Borsten, die weit länger sind als der Griffel (Abb. C). Penis klein, distal mit 2 feinen Spitzen.



Obere Reihe : *A. macrophthalmus* nov. spec.; mittlere Reihe : *A. hispidulus* Klug; untere Reihe: *A. pilosus* H.S. — A = Kopf von oben (22,5 ×); B = Schildspitze (11,2 ×); C = Geitalgriffel, seitlich (47,5 ×).

A. macrophthalmus nov. spec. steht *A. pilosus* H.S. und *A. hispidulus* Klug sehr nahe, ist aber grösser und unterscheidet sich vor allem von diesen beiden Arten durch das grosse, vorspringende Auge und die schmale Schildspitze. Bei *A. pilosus* ist der Scheitel 4,1 mal und bei *A. hispidulus* 4,8 mal so breit wie das kleine Auge, das seitlich kaum über die Kopfseiten vorsteht (Abb. A). Die Ocellen sind hier auch viel weiter vom Auge entfernt Auch die Schildspitze ist anders geformt; sie ist hier viel breiter, stumpfwinklig und der Seitenrand vor der Spitze kaum geschweift (Abb. B). Von *A. sculptus* Gerst. aus Ostafrika, der gleichfalls eine schmale Schildspitze hat, unterscheidet sich unsere neue Art durch die grossen Augen und den breiten Kopf.

Ich untersuchte 2 ♂♂ und 5 ♀♀ aus Aegypten : Ghezireh, iii.1910, 1 ♂, Alfieri leg.; Meadi, 14.v.33 (1 ♀), 21.v.30 (1 ♀), 26.v.30 (1♀); Gebel Elba, i.33 (1 ♀); sämtlich Priesner leg.

Holotype und Paratypoide in meiner Sammlung, Allotypoid und Paratypoide in der Sammlung H. Priesner.

Ich möchte nicht versäumen, Herrn Prof. H. Priesner, Kairo, dem ich das Material zu den obigen Beschreibungen verdanke, auch an dieser Stelle für seine liebenswürdige Unterstützung bei meinen Arbeiten recht herzlich zu danken.

2

The effect of Age on the Host-selection principle

(with 7 Tables) E.M.

by Dr. H.T. ZAAZOU
Faculty of Agriculture, Farouk I University, Alexandria.

INTRODUCTION

One of the most interesting principles recently developed in economic Entomology, is the host-selection principle.

As defined by Hopkins (1917), this principle is that an insect species which breeds in two or more hosts prefer to continue to breed in the host to which it has become adapted. By carrying this principle to its extreme hypothetical conclusions we would have developed from a progeny of one polyphagous insect species, a great number of distinct species each in turn being monophagous.

Without reviewing all the literature dealing with this principle some of the outstanding experiments may be mentioned.

According to Craighead (1923), Walsh was probably the first entomologist to state this principle definitely in concise words. The following quotation is taken from his work published in 1864.

"Even with the little we know of the law of inheritance, we might infer a priori, that from a peculiar circumstances a phytophagic variety, including both sexes, has fed for a great many generations upon one particular plant of the number inhabited by the species to which it belongs, it would be likely to transmit to its descendants in the image state a tendency to select that particular plant to deposit its eggs. If then it should happen that owing to the presence of but a single species of that plant ordinarily fed upon by a particular species of insects, or to other causes, eggs have been uniformly deposited by a phytophagic variety upon the same plant for an indefinitely long series of generations, say fifty, or a hundred, or a thousand, and the female has in no case intercrossed with a male belonging to a different phytophagic variety, then it is probable that habit will become a second nature, and it will cease to be possible for that insect to feed upon any oher plant than that to which it has become habituated by the laws of inheritance".

More than fifty years later Craighead (1922) found that a species of wood boring Cerambycid beetle (*Cyllene robiniae* Forst. = *picta* Drury), acted in the way described by Walsh. One of Craighead's conclusions was : "In practically all the species experimented with the adults show a marked predilection for the host in which they have fed as larvae, provided they are not deterred by factors, such as unfavourable conditions or the small quantity of hosts".

Larson (1927) discussed the host-selection principle very fully and tested it with reference to the Cowpea weevil (*Bruchus (Callosobruchus) quadrimaculatus* F.). His results were not in accordance with those of Craighead. He found that this insect showed no marked preference for the host in which it had been bred.

Thompson and Parker (1928) examined the principle with the corn borer (*Pyrausta nubilalis* Hb.). Their experiments showed that the corn borer exhibited no marked preference for the plant on which it has been bred for many generations.

Torpe's experiments (1929-1931) with the moth *Hyponomeuta padellus* L. lend strong support to the host-selection principle.

Thorpe and Jones (1938) used an olfactometer of the Mac Indo type to investigate the host-selection principle or the conditioning effect as applied to the endoparasitic Ichneumonid (Hymenoptera) *Nemeritis canescens* Grav. After several experiments they concluded that there is a strong germinally fixed tendency in *Nemeritis canescens* Grav. to follow up the odour of the Pyralid moth *Ephestia kuehniella* Zell. (primary host).

The writer, while working with *Bruchus* (*Acanthoscelides*) *obtectus* Say (1943) found that rearing the weevils on haricot beans, which is not a favourable host, for 13 generations, caused an increase in the number of eggs deposited by the females on haricot beans, but the majority of eggs was laid on pea bean.

From the few examples mentioned above, it became clear that some evidence supported the host-selection principle while others did not.

Most workers who dealt with that principle overlooked two important factors which might influence the insects while selecting their hosts. How does the age of insects affect their selection of their favourable hosts ? In other words does the strength of the chemical sence responsible for the selection of hosts differ according to the age of insects ? The previous infestation of hosts and its effect on the host-selection principle.

To investigate these factors three Bruchid beetles were choosen, *Bruchus* (*Acanthoscelides*) *obtectus* Say, *Bruchus* (*Callosobruchus*) *maculatus* F. and *chinensis* L. This paper deals with the effect of age. The previous infestation of hosts and its effect on the host-selection will be discussed in another paper.

TECHNIQUE

The Bruchidae as a whole are phototropic insects, so to eliminate the effect of light, all the experiments were conducted in complete darkness in a wooden box the cover of which overlapped the sides. Several Petri dishes were divided into eight equal compartments by cardboard stripes. There was an over head clearance of 1 cm. which allowed the contained insects free movements. The bottom as well as the edges of all the Petri dishes were covered with black paper. After introducing the weevils all the dishes were covered with black muslin secured by rubber bands.

Four of the compartments were filled with the various hosts which were kept at 75 % R.H. for 8 weeks. The different hosts were put in four alternate compartments to separate the hosts so that the stimulus given by one host should not lead the female weevil to oviposit on the neighbouring less attractive host separated from it only by a cardboard stripe.

About 30 to 40 newly emerged Bruchids (2 days old) were scattered over the compartments. They ran at once in all directions and there was no question of crowding in any quarter. After five days of incubation, eggs in each compartment were counted. The dishes were cleaned thoroughly with a dry duster and a fresh supply of the same hosts was put in four compartments in the same arrangement as during the first five days. The same Bruchids which laid eggs for the first five days were scattered again over the compartments. After another five days of incubation eggs in each compartment were counted.

The experiments on *Bruchus* (*Acanthoscelides*) *obtectus* Say were carried out at constant temperature of 25° C, while those on *Bruchus* (*Callosobruchus*) *maculatus* F. and *chinensis* L. were carried out at room temperature which fluctuated from 23 to 28° C.

Bruchus (Acanthoscelides) obtectus Say

The different hosts used with this species were pea bean, white kidney bean, red kidney bean and black valentine bean. Bruchids used were reared on red kidney bean. The results are shown in Table I (figures represent the average for 10 trials).

TABLE I

HOSTS	FIRST SPATE OF OVIPOSITION		SECOND SPATE OF OVIPOSITION	
	NUMBER OF EGGS	PERCENTAGE	NUMBER OF EGGS	PERCENTAGE
Red kidney bean	86	25.9	38	29.3
White kidney bean	85	25.6	33	25.3
Black valentine bean	47	13.2	30	23.5
Pea bean	113	34.1	28	21.7

These figures show that during the first spate of oviposition, pea bean received the greaetest number of eggs, over 34 % of the total eggs was deposited on it. Red kidney beans, on which the Bruchids were reared, was not the favourable host, i.e. the host-selection principle did not apply to *Bruchus (Acanthoscelides) obtectus* Say. The difference between the highest percentage which was deposited on pea bean and the lowest which was received by black valentine bean was nearly 20 %. This great difference indicated that during the first spate of oviposition the female Bruchid had a great attraction for pea bean.

During the second spate of oviposition the situation was quite different. Pea bean did not receive the highest number of eggs, the percentage of eggs laid on the remaining hosts increased, and the difference between the highest percentage which was received by red kidney beans, and the lowest one received by pea bean, was very small, 7.6 %. This insignificant difference shows that the hosts received nearly equal number of eggs. There was not much discrimination during the second spate of oviposition between the different hosts.

To obtain more results, experiments with Bruchids reared on haricot beans for over two years were carried out. In all these trials, black valentine beans were replaced by haricot beans. The results are shown in Table II (figures represent the average for 10 trials).

TABLE II

HOSTS	FIRST SPATE OF OVIPOSITION		SECOND SPATE OF OVIPOSITION	
	NUMBER OF EGGS	PERCENTAGE	NUMBER OF EGGS	PERCENTAGE
Red kidney bean	59.9	18.9	45.7	31.8
White kidney bean	48.3	15.3	38.0	26.6
Black valentine bean	184.8	58.5	38.8	27.2
Haricot bean	22.7	7.2	20.0	14.1

The figures given in this Table confirm the results obtained in the previous experiments. During the first spate of oviposition, pea bean received the highest number of eggs, over 58 % of the total eggs. Haricot bean on which the Bruchids had been reared for nearly 14 generations received the lowest number of eggs. The significance of this fact cannot be overlooked, 14 generations on a new host have not impaired in the least degree the attraction for pea bean. The difference between the highest and the lowest percentage was more than 50 %. During the second spate of oviposition there was not much discrimination between the different hosts. The percentage of eggs laid on all the hosts apart from pea bean was greatly increased.

Further experiments with only two hosts were carried out. The different hosts were (a) pea bean which is the favourite host, (b) haricot bean on which the Bruchids were reared for two years. The hosts were separated by three empty compartments. The Bruchids used were divided into two lots, each lot was put in the middle empty compartments. By this arrangement the Bruchids were separated from the hosts by an empty compartment. The experiment was repeated sixteen times and the results which are the average are given in Table III.

TABLE III

HOSTS	FIRST SPATE OF OVIPOSITION		SECOND SPATE OF OVIPOSITION	
	NUMBER OF EGGS	PERCENTAGE	NUMBER OF EGGS	PERCENTAGE
Pea bean....................	16.4	79.8	74.3	64.1
Haricot bean.................	41.6	20.2	40.4	35.8

These figures showed that during the first spate of oviposition nearly 80 % of the total eggs was laid on pea bean, the rest 20 % was received by haricot bean on which the Bruchids were reared for more than two years. During the second spate of oviposition only 64 % was laid on pea bean while 36 % was laid on haricot bean. The attraction for pea bean was not as strong as it was during the first five days of the adult life. In all the experiments which dealt with two hosts the female Bruchid preferred pea bean during both spates of oviposition, but this preferrence was very strong when the Bruchids were young.

Bruchus (Callosobruchus) maculatus F.

To obtain further information, experiments were carried out with *Bruchus (Callosobruchus) maculatus* F. (cowpea weevil). The different hosts used were cowpea, broad bean, string bean and peas. All the hosts were kept at 75 % R.H. for nearly two months at room temperature. The Bruchids used were reared on broad beans for nearly six months. The results which are the average for ten trials are shown in Table IV.

TABLE IV

HOSTS	FIRST SPATE OF OVIPOSITION		SECOND SPATE OF OVIPOSITION	
	NUMBER OF EGGS	PERCENTAGE	NUMBER OF EGGS	PERCENTAGE
Broad bean....................	112	26.3	56	26.1
Cowpea	158	36.3	67	31.3
String bean....................	95	22.1	48	22.4
Peas..........................	64	14.9	43	20.1

These figures showed that during the first spate of oviposition cowpea received the highest number of eggs. There was a marked preference for cowpea. During the second spate of oviposition there was not much discrimination between the different hosts.

More experiments were done with two hosts, cowpea and broad beans. The Bruchids used were reared on broad beans for nearly six months.

The results are shown in Table V.

TABLE V

HOSTS	FIRST SPATE OF OVIPOSITION		SECOND SPATE OF OVIPOSITION	
	NUMBER OF EGGS	PERCENTAGE	NUMBER OF EGGS	PERCENTAGE
Cowpea	180	76.1	74	55.6
Broad bean	56	23.8	59	44.3

Figures in this Table shows that cowpea received over 76% of the total egg during the first spate of oviposition, very strong preference, while in the second spate of oviposition it received only 55.6%. The attraction for cowpea was weakened during the second spate of oviposition.

Bruchus (Callosobruchus) chinensis L.

The same experiments were repeated with *Bruchus* (*Callosobruchus*) *chinensis* L. The hosts used were broad beans, cowpea, string bean, and peas. Bruchids used were reared on broad beans. The results are shown in Tables VI and VII.

TABLE VI

HOSTS	FIRST SPATE OF OVIPOSITION		SECOND SPATE OF OVIPOSITION	
	NUMBER OF EGGS	PERCENTAGE	NUMBER OF EGGS	PERCENTAGE
Brood bean	88	21.4	63	23.5
Cowpea	132	32.5	75	27.9
String bean	110	27.1	69	25.7
Peas	76	18.6	61	22.8

It is clear from the above figures that the host-selection principle does not apply to *Bruchus* (*Callosobruchus*) *chinensis* L. Cowpea was the favourite host during both spates of oviposition. The attraction of cowpea was very strong during the first half of the Bruchids' life, but got weaker when the Bruchids got older.

TABLE VII

HOSTS	FIRST SPATE OF OVIPOSITION		SECOND SPATE OF OVIPOSITION	
	NUMBER OF EGGS	PERCENTAGE	NUMBER OF EGGS	PERCENTAGE
Cowpea	156	67.2	79	55.6
Broad bean	76	32.7	63	44.3

SUMMARY

(1) The host-selection principle does not apply to the three Bruchids used.

(2) Rearing *Bruchus* (*Acanthoscelides*) *obtectus* Say for nearly two years on haricot bean, *Bruchus* (*Callosobruchus*) *maculatus* F. and *chinensis* L. for seven months on broad bean, did not alter their choice of their favourite hosts which were pea bean and cowpea.

(3) The attraction for the favourite host was very strong during the first half of the adults' life. It received the highest number of eggs.

(4) During the second half of the adults' life, the attraction for the favourite host got weaker. The Bruchids oviposited indiscriminately on all the different hosts.

(5) The hosts on which the Bruchids were reared received more eggs during the second half of the adults' life.

(6) The chemical sence responsible for the choice of hosts is not constant, but varies according to the age of insects. It is usually very strong when the insects are young and gets weaker as they get older.

ACKNOWLEDGMENTS

The firt part of this work was carried at the Biological Field Station, Slough (England). I am indebted to Dr. C.W. Richards for criticisms and suggestions. The part dealing with *Bruchus* (*Callosobruchus*) *maculatus* F. and *chinensis* L. was carried at the Ministry of Agriculture, Cairo. I would like to thank Mohamed Soliman El-Zoheiry Bey, the director general of the Plant Protection Department, for his advise and support. My thanks are also due to Risk Attia effendi for helping and for supplying the material used in this work.

BIBLIOGRAPHY

Chamberlin, W.J. (1946) : Entomological Nomenclature, Oregon State College.

Craighead, F.G. (1922) : *Jour. Agri. Res.*, XXII, No. 4.

Craighead, F.G. (1923) : *Canadian Entomologist*, LV, No. 4.

Hopkins, A.D. (1917) : U.S. Dept. Agric., Program of work 1914.

Larson, A.O. (1927) : The host-selection principle as applied to *Bruchus quadrimaculatus* (*Ann. Entom. Soc. Amer.*, XX).

Thompson and Parker (1936) : *Bull. Entom. Res.*, XVIII.

Thorpe (1929) : *Jour. Linn. Soc. Zool.*, XXXVI.

Thorpe (1930) : *Biol. Rev.*, V, p. 177.

Marimoto, S. (1939) : The host-selection of *Callosobruchus chinensis* (Oyo Kontyû, I, Tokyo).

Zaazou, H.T. (1948) : Oviposition of the Bean Weevil *Acanthoscelides obsoletus* Say (*Bull. Soc. Fouad I Entom.*, XXXII).

A Morphological and Biological Study of *Culex pipiens* in the Cairo Area of Egypt (1)

[Diptera-Culicidae]

by Kenneth L. Knight, L.CDR., M.S.C., U.S.N.,
and Albert A. Abdel Malek (2),
U.S. Naval Medical Research Unit No. 3, Cairo, Egypt.

INTRODUCTION

For many years now it has been well known that *Culex pipiens* Linnaeus exhibits a large amount of rather bewildering morphological and biological variation throughout the extent of its geographical range. This variation has been the subject of extensive investigation by many different workers. The dominanant tendency has been to treat the observed variation as being at the subspecies level or above, and to ascribe names with official nomenclatorial standing to different segments of this variation. However, as a result of recent reviews of the entire problem (Mattingly *et al*, 1951 and Mattingly, 1951), it has become apparent that many of these differences probably occur no higher than at the individual variant level, and if varieties are to be named at all, they should be designated solely with non-commital or vernacular names (see Mayr, 1942, p. 104, for a discussion of the present status of the term "variety").

With this probability in mind, it is apparent that one of the next stages in the problem of clarifying the variability of *pipiens* is a detailed study of the different associations of variable morphological and biological characters which may be found at the local population level, and the subsequent correlation of these associations with their seasonal and geographical distri-

(1) The opinions or assertions contained herein are the private ones of the workers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

(2) Guest research member, from the Faculty of Science at Fouad I University, Cairo, Egypt.

bution. From such a study it should eventually be possible to assess rather accurately the value of variability in the *pipiens* complex and to arrive at some logical conclusions regarding the taxonomic terminology applicable to it.

A preliminary attempt of this type, based on analysis of the previously published data of other workers, has been made for the *pipiens* complex by Hovanitz (1947). His purpose was to show the occurrence of parallel series of biological and morphological characters in diverse groups of insects, mostly mosquitoes. The characters compared were : larval development and adult activity at low temperatures, diapause, space requirements for copulation, ecological distribution, adult body coloration, larval tolerance to dense infusions of micro-organisms and to salt solution, adult food requirements, and morphological aspects (number of branches of hairs and comparative lengths of structures). Unfortunately, little of the data available to him for the *pipiens* complex was truly comparable but the sum total of his character tabulations implies that the *pipiens* variation can possibly be explained on a climatic clinal basis.

Whether or not the variation in the *pipiens* complex is truly clinal in nature, this work by Hovanitz is important in that it clearly shows the inadequacy of the existing data for studies of this type.

The purposes of the study reported here in this paper were as follows : to examine those morphological and biological characteristics of the Cairo *pipiens* population that have previously been purported to have diagnostic value ; to measure and to express these characteristics in such a manner that they can be compared with the similar characteristics of *pipiens* populations from other regions ; and, to attempt to arrive at some conclusion concerning an acceptable functional taxonomic terminology applicable to this population. It is planned to study populations from other portions of Egypt as time permits.

The need for work on *pipiens* in Egypt has been particularly indicated because it is the site of origin of the name *molestus* Forskal (1775), a name which has come to be rather generally used to designate the form of *pipiens* combining the characteristics of autogeny, stenogamy, homodynamy, and man-biting. This usage however, has developed solely on the basis of circumstantial evidence. Whether or not a form of *pipiens* that possesses this combination of characters actually exists in Egypt has not been previously determined.

METHODS

The *pipiens* population of the area immediately surrounding Cairo was sampled by making numerous collections of the immature stages from as many different types of breeding places as possible. Although none of the

collection sites were within the city proper, all were suburban in type. Samples were collected in all the seasons of the year except winter.

Ideally, in order to reduce to a minimum the opportunity for other than natural selective forces to act upon the samples, only field-collected pupae should have been used. However, this was seldom entirely possible and consequently most of the samples consisted of larvae as well as pupae.

In the laboratory, the larvae were placed in glass jars and the pupae in cotton-stoppered flasks. The larvae were fed upon pellets of a standard laboratory rabbit food (prepared and marketed by J.W. Eshelman and Sons, Lancaster, Pennsylvania) supplemented by very small amounts of a dilute aqueous suspension of Mead's brewers yeast powder.

Upon emergence the adults were counted and released into wire-screened, wooden-framed cages 10 inches in each dimension. The cages were provided with glass tops and wooden floors, and the screening of one side was replaced by a fabric sleeve. As adults became available, they were added to the cages until at least 100 individuals of each sex were present. The total number of females introduced ranged as high as 139, but in most cases was between 100 and 115. Only one cage per sample was used. Oviposition dishes and cotton wicks soaked with table sugar solution were available to the adults at all times.

Following the introduction of the last adults into the cages a period of 12 days was allowed to elapse in order to permit the laying of all autogenous rafts. The percentage of females capable of laying autogenously was calculated at this time by dividing the number of autogenous egg rafts laid by the number of females originally placed in the cage. This percentage is obviously somewhat lower than it should be, because some of the females die during the 12 day period and among the number that die are possibly some individuals that would have oviposited autogenously if they had lived. In the series studied, an average of 9 females died in each cage from the time of first introduction to the end of the 12 day period, with a range of 1 to 23.

On the 12th day, 10 females were taken from each cage and their spermathecae dissected to determine the rate of fertilization. The percentage obtained was used as a measure of the stenogamic characteristic of the sample.

Also on the 12th day, from each sample 30 females were segregated into a 4000 cc. glass beaker and 30 females into a five inch cubical wire-screened cage. The females in the beaker were allowed a 30 minute period to feed upon a human hand, the same host individual being used throughout. Those in the cage were allowed a similar time to feed upon the inner plucked surface of a pigeon wing. The containers were covered with black

cloth during the feeding period. All of the feeding was done at approximately mid-day. At the end of the 30 minute period, the percentage of blooded females in each container was determined, this figure serving as an indication of the ability of the adults in each collection to feed upon man and upon birds.

Following feeding, the blooded females were kept for approximately 25 days to permit oviposition. The shape, number of eggs, and the percentage hatch were determined for each egg raft. Similar data were recorded for autogenous rafts.

Ten to 20 adults with associated larval and pupal skins were preserved from each sample. The study of morphological characters was made from this material. The temperature and relative humidity data are shown in Table I.

RESULTS

Morphological characteristics (Table II)

Male : First four segments of the palpi equaling 0.83-1.00 the length of the proboscis and labella, segments I-III are 2.75-3.87 times longer than segment IV, and 2.50-3.55 times longer than segment V; segment III straight or no more than slightly curved in lateral view. Scutal integument dark brown; scutal scaling yellowish- and reddish-brown, paler scaling present over and before wing bases, along anterior margin, and around prescutellar area. Hind tibial apex with an anterior pale-scaled area of variable size, nearly always faintly visible to the naked eye but microscopically not in sharp contrast to the remainder of the leg. Anterior fork cell of wing 2.14-3.80 times as long as its stem. Tergite II with a baso-median cream-colored spot; III-VII with basal yellowish bands, which may be either concave, straight, or convex posteriorly, the bands produced a variable distance posteriorly along the lateral margins on V-VII, sometimes also on III-IV; the dark scaling not showing metallic blue reflections. Sternites pale-scaled, sometimes few to many dusky scales present along the midline only. Of 30 males specifically checked, 20.3 per cent had dusky medial scaling on sternites V-VI. Genitalia : The dorsal processes of the lateral plates of the mesosome broad and noticeably truncate apically. The outwardly directed points of the ventral processes nearly always lying within the limits of the outer margins of the apices of the dorsal processes. Only one specimen out of 34 examined had the apices of the ventral processes extending beyond the outer limits of the dorsal processes. The DV/D ratio (Sundararaman, 1949) with a range of positive 0.02 to negative 0.14 (DV being the distance between the outer apical margins of the dorsal and ventral arms, and D being the distance between the outer apical margins of the dorsal arms). Lobes of the ninth tergite each bear 5-13 setae.

Female : Markings as in the male. Anterior fork cell of wing 3.12-6.60 times as long as its stem. Fewer individuals with dusky scaling along mid-line of the sternites. Of 74 females specifically checked, only 12.8 per cent had dusky medial scaling on sternites V-VI. Lobes of the ninth tergite each bear 5-20 setae.

TABLE I

Laboratory temperature and relative humidity during period of experimentation.
Temperature data based on 12 readings per 24 hour period.
Relative humidity data based on 6 readings per 24 hour period.

MONTH	TEMPERATURE IN °F			RELATIVE HUMIDITY		
	Average	Minimum	Maximum	Average	Minimum	Maximum
April	79.5	74.0	86.0	50.5	32	62
May	78.8	72.0	90.0	48.6	20	68
June	84.3	78.0	92.0	53.5	28	80
July	87.0	76.0	94.0	57.5	26	84
August	87.0	82.0	93.0	59.1	31	85
September	84.5	79.0	93.0	63.0	27	84
October	79.5	73.0	87.0	63.8	41	80
November	75.6	69.0	90.0	68.3	20	90
December	70.0	64.0	75.0	68.3	39	87

TABLE II

Summary of adult morphological data for Cairo pipiens

STRUCTURES STUDIED		NUMBER OF EXAMPLES	RANGE		AVERAGE
			Minimum	Maximum	
Palpal segments I-V / Proboscis + labella		50	0.83	1.00	0.92
Palpal segments I-III / Palpal segment IV		50	2.75	3.87	3.18
Palpal segments I-III / Palpal segment V		49	2.50	3.55	2.91
Anterior fork cell / Anterior fork cell stem	male	35	2.14	3.80	2.78
	female	47	3.12	6.60	4.17
Number of setæ on each of ninth tergal lobes	male	118	5	13	8.74
	female	98	5	20	10.31
DV/D (male genitalia)		34	− 0.14	+ 0.02	− 0.07

Egg : Reticulated area on outer thickened portion of base of micropylar cup equal to, or only slightly wider than, the immediately-following smooth area; reticulations distinct.

It was noted that in general the eggs in rafts from blooded females were more often regularly arranged than those in autogenous rafts.

TABLE III

Shape of egg rafts of Cairo pipiens

TYPE OF BLOOD	NUMBER OF COLLECTIONS REPRESENTED	NUMBER OF RAFTS	PERCENTAGE OF TOTAL OF EACH SHAPE						
			BOAT	RIBBON	TRIANGULAR	RECTANGULAR	CIRCULAR	OVAL	IRREGULAR
No blood..............	11	32	40.6	9.4	9.4	9.4	9.4	0.0	21.8
Human blood..........	18	230	44.3	22.2	7.8	5.2	7.4	6.1	7.0
Pigeon blood..........	12	68	48.5	33.8	7.3	5.9	1.5	0.0	3.0

TABLE IV

Egg production and percentage viability of the eggs of Cairo pipiens.
All of the eggs from adults reared from field-collected larvae.

TYPE OF BLOOD	NUMBER OF COLLECTIONS REPRESENTED	NUMBER OF RAFTS	NUMBER OF EGGS PER RAFT			PERCENTAGE HATCH		
			MINIMUM	MAXIMUM	AVERAGE	MINIMUM	MAXIMUM	TOTAL HATCH
No blood......	11	32	12	85	47.6	34.0	100.0	83.3
Human blood..	18	208	5	148	56.3	0.0	100.0	84.1
Pigeon blood...	12	68	20	162	94.4	0.0	95.6	83.8

Over 40 per cent of all rafts examined were boat-shaped, regardless of whether the females were fed or whether the females had fed upon human or pigeon blood (Table III). The ribbon-shaped raft was the next most common type laid by those females which had fed on human or pigeon blood. However, this was not true of the autogenous rafts where the second most common type was the irregular-shaped raft. The remainder of the rafts were circular, triangular, oval, or rectangular in shape.

As shown by Table IV, females which had fed on pigeon blood produced larger rafts than those which had fed on human blood, and the rafts of both were larger than the autogenous rafts.

There was no appreciable difference in the average hatching rate of eggs from each of these sources (Table IV). However, none of the autogenous rafts were sterile, whereas sterile rafts were obtained from females fed on either pigeon or on human blood.

Fourth Stage Larva : Morphological data for the larval stage are summarized in Table V. In addition it was noted that the antennae of all specimens examined were uniformly gray or brownish pigmented. In general, the shapes of the siphon, of the siphon valves, and of the valve lever were found to be too variable to permit accurate description. Since the larvae

TABLE V

Summary of larval morphological data for Cairo pipiens

STRUCTURE STUDIED		NUMBER OF EXAMPLES	RANGE		AVERAGE
			MINIMUM	MAXIMUM	
Number lateral mental teeth / 2		187	8	13	10.2
Siphon index		98	2.7	4.7	3.7
Siphon hair tufts	first tuft	164	2	7	3.7
	second tuft	163	1	9	3.5
	third tuft	168	1	5	2.9
	fourth tuft	168	1	6	2.9
	fifth tuft *	23	2	5	3.3
Number branches in anal brush		70	65	112	89.1
Dorsal papilla length / Anal plate length		90	0.6	1.7	1.2
Number of pecten teeth		200	11	19	14.2

* Only one per cent of all larvae examined had one or both members of a fifth pair of tufts and of the total of 14 larvae observed with a fifth pair, 10 were from a single larval collection. No larvae were seen with less than four pairs of tufts.

used for study were all collected in the field, the anal papilla index given in Table V represents at least partially the salinity of the original breeding water. The dorsal anal papilla index of 24 larvae, from three distinct collections, reared in laboratory tap water from the time of hatching ranged from 1.1 to 1.8, with an average of 1.4.

Biological characteristics (Table VI)

Autogeny : From the data presented in Table VI it can be seen that only a very small percentage of the females of the Cairo *pipiens* population are capable of laying autogenous rafts. However, it is obvious that at least a proportion of the remaining females carry the character for autogeny in a suppressed condition, since three samples originally negative for autogeny produced autogenous egg rafts when reared into the second generation.

Stenogamy : All of the 19 *pipiens* samples tested produced fertile eggs while enclosed in a space of 1000 cubic inches. On the basis of presently accepted standards (Mattingly *et al*, 1951) all of these samples would therefore be considered to be stenogamous.

It is of interest here that only 84 per cent of dissected females from August collections were fertilized, whereas 100 per cent of those from October and November were found to be inseminated. The fact that the highest minimum laboratory temperature was recorded in August indicates that the effect of high temperatures on the rate of fertilization should be investigated further.

TABLE VI

Summary of the diagnostic biological characteristics of the Cairo pipiens *population.*

SAMPLE NUMBER	DATE COLLECTED	HABITAT	PERCENTAGE AUTOGENY: FIRST GENERATION	PERCENTAGE AUTOGENY: SECOND GENERATION	PERCENTAGE STENOGAMY IN SPACE VOLUME OF 1000 CU. INCHES	PERCENTAGE FED ON: MAN	PERCENTAGE FED ON: PIGEON
A	IV	well	+	+	+		
B	IV	cess pit	+	+	+		
83	V	well	0.0		+		
85	V	well	0.0		+		
101	VIII	well	0.0	1.2	100.0		
102	VIII	ditch	2.9		72.7**		
104	VIII	well	0.0		90.0		
106	VIII	cement basin	0.0		70.0		
110	VIII	ground pool	0.0	0.0	90.0		
113	IX	cement basin	0.0		100.0		
114	IX	ditch	2.6		80.0		
129	IX	ground pool	3.2		100.0	70.0	5.0
132	X	well	0.0	1.7	100.0	46.7	23.3
135	X	well	2.2		100.0	23.3	50.0
138	X	well	2.0		100.0	20.0	16.7
139	X	well	0.0	3.0*	100.0	30.0	66.7
149	XI	borrow pit	0.0		+	16.7	20.0
151	XI	cement basin	4.0		100.0	13.3	3.3
152	XI	ditch	1.4		+	33.3	26.7
Average			1.1	1.1	92.4	30.0	19.6
Range			0.0 to 4.0	0.0 to 3.0	70.0 to 100.0	13.3 to 70.0	3.3 to 66.7

* Probably abnormally high since the cage contained only 33 females.
** Eleven females were dissected.

Limited observations of the mating act indicated that it is initiated in the air and consummated while resting either on the side of the cage or on the floor. A brief period in the vertical poise (face to face) occurs, followed by a longer period in the end to end poise. These observations were made at approximately mid-day.

Homodynamy: Since *pipiens* eggs can be found in the Cairo area throughout the year, it is obvious that at least a homodynamic strain exists here.

Capacity to Feed on Man : Each of the tested samples accepted human blood, as well as pigeon blood. The percentage feeding on either type of blood varied widely from sample to sample. However, no significance should be given to the variation *per se.*, since laboratory climatic conditions were not controlled. It remains that the fact of human blood acceptability is definitely established for the Cairo population.

Larval Habitat : Larvae were found in habitats varying from clean, clear-water ground pools to murky, strongly-polluted cesspools. The pH ranged from 7.8 to 8.7 and the chloride content from 0.01 to 0.46 per cent. Observations are still too limited to determine whether any correlation exists between the larval environment and the characteristics of the adults.

DISCUSSION

Mattingly *et al* (1951), have reviewed the diagnostic information available in the literature for the various described forms of the *pipiens* complex found in the Palàearctic region. A comparison of the morphological and biological characteristics associated together in the Cairo population of *pipiens* discloses that in general this population conforms well with their summary for the form "molestus". The only characters with which conformance was clearly lacking were the following : the shape of the third male palpal segment ; the form of the reticulations of the floor of the micropylar cup of the egg ; the shape of the larval siphon, the siphonal valves, and of the valve lever ; and the number of pecten teeth. It is of possible significance here that none of the above characters have been reported in the literature as of diagnostic value by more than one author.

Mattingly (1951) has pointed out that the association of morphological and biological characters supposed to typify form "molestus" is a local phenomenon and has been demonstrated clearly only in large cities. Because of this, he suggested that it should be treated for the present as an urban biotype and given the non-committal name of variety or form "molestus". Since the Cairo *pipiens* population resembles this biotype in all essential details, it is being considered by us under the name *Culex pipiens* L., form [3] "molestus". Whether or not, it will prove to be confined to urban areas in Egypt is a problem which must await further investigation.

It is of interest to note that although Kirkpatrick (1925) described Egyptian *pipiens* as having a siphon index as high as 5.2, the male palpi longer than the proboscis by the length of the terminal segment and half of the penultimate segment, and the tergal bands sometimes incomplete, no

(3) The term « form » is defined by Mayr (1942, p. 108) as a single unit of an incompletely analyzed species complex.

material of this type has yet been found by us in the Cairo area. However, the implication remains that material may be found somewhere in Egypt that is not typically form "molestus", at least on morphological characters.

To date, no material resembling *fatigans* Wiedemann has been found by us or other contemporary workers in Egypt.

Roubaud (1933) described a member of the *pipiens* complex from Algeria under the varietal name *berbericus* which he regarded as being distinct because it combined the characters of being anautogenous, stenogamous, homodynamous, and mammal-biting. Later, Roubaud (1939) found that it may sometimes exhibit autogeny, but attempted to explain this (1945) by saying that the involved material was probably hybrid. Now, in view of the low percentage of first generation adults of the Cairo population that are capable of laying autogenously, it seems most likely that the Algerian biotype studied by Roubaud is completely similar and should also be known as form "molestus".

At present, the available data for other areas of the Palaearctic and Ethiopian ranges of *pipiens* are too meager to allow for further discussion of the concept of a climatic cline as suggested by Hovanitz (1947). However, when the percentage occurrences of various of the pertinent morphological and biological characters of the complex are known from adequate samples from many different points within the geographical range, it is felt that the possibility of the existence of such a cline in the *pipiens* complex should be investigated.

The authors wish to express their indebtedness to Mr. P.F. Mattingly, British Museum (Natural History), for his critical assistance throughout this work.

SUMMARY

The morphological and biological variability of the suburban Cairo population of *Culex pipiens* L. has been investigated for the period of April through November of one year. This population has been found to be stenogamous and homodynamic, to be capable of feeding on humans as well as birds, and to possess a low percentage of females capable of ovipositing autogenously. Its morphological features have been described and found to correspond in general with those of the similar biotype in continental Europe and England. It is proposed that the vernacular name, form "molestus", be applied to this population.

LITERATURE CITED

Hovanitz, W. (1947) : Occurrence of parallel series of associated physiological and morphological characters in diverse groups of mosquitoes and other insects (contr. Labr. Vertebrate Biol., Univ. Michigan, XXXII, 24 pp.).

Kirkpatrick, T.W. (1925) : The mosquitoes of Egypt (224 pp., Government Press, Cairo).

Mattingly, P.F. (1951) : The problem of biological races in the *Culex pipiens* complex (In press).

Mattingly, P.F., Rozeboom, L.E. Knight, K.L., Laven, H., Drummond, F.H., Christophers, S.R. and P.G. Shute (1951) : The *Culex pipiens* complex (In press).

Mayr, E. (1942) : Systematics and the origin of species (334 pp., Columbia University Press, New York).

Roubaud, E. (1933) : Essai synthétique sur la vie du moustique commun (*Culex pipiens*). L'évolution humaine et les adaptations biologiques du moustique (*Ann. Sci. nat.* (Zool.), Ser. 10, XVI, pp. 5-168).

Roubaud, E. (1939) : Le pouvoir autogène chez le biotype nord-africain du moustique commun, *Culex pipiens* L. (*Bull. Soc. Path. exot.*, XXXII, pp. 172-175).

Roubaud, E. (1945) : Le problème de l'espèce chez le moustique commun *Culex pipiens* L. (*Bull. Soc. Path. exot.*, XXXVIII, pp. 47-60).

Sundararaman, S. (1949) : Biometrical studies in the intergradation in the genitalia of certain populations of *Culex pipiens* and *Culex quinquefasciatus* in the United States (*Amer. J. Hyg.*, L (3), pp. 307-314).

Chalcidiens orientaux introduits en Egypte

[Hymenoptera]

(avec 2 Figures)

par CH. FERRIÈRE, D.Sc., Genève.

Pour lutter contre la cochenille blanche de l'Hibiscus, *Phenacoccus hirsutus* Green, une des plus importantes cochenilles d'Egypte, plusieurs Chalcidiens ont été introduits de Java. Le parasite le plus efficace, *Leptomastix phenacocci* Compere, a été décrit en 1939 et a été acclimaté en Egypte. Nous avons reçu du Dr. H. Priesner, de la section entomologique du Ministère de l'Agriculture, trois autres espèces à étudier ; ces trois espèces sont très probablement hyperparasites et sont à éliminer de la lutte contre *Phenacoccus*, mais elles sont intéressantes et deux d'entr'elles, nouvelles, sont décrites ici.

Une de ces espèces correspond à l'*Eurymyiocnema aphelinoides* Compere (1947), décrit d'après des exemplaires provenant de Buitenzorg, Java, et de l'Afrique orientale, parasites d'un *Leptomastix* sp. dans les cochenilles, *Pseudococcus lepelleyi* Betrem. Compere place avec raison, à notre avis, ce genre dans les *Aphelinidae*, dans un groupe renfermant aussi *Myiocnema* Ashm. et *Euryischia* Riley. Cependant, d'après Ghesquière i.l., le genre *Eurymyiocnema* est synonyme de *Eriaporus* Waterston (1917), qui avait été décrit dans les *Miscogasterinae*, et qui renferme une espèce de l'Afrique occidentale, *E. laticeps* Wat. L'espèce de Compere, qui doit s'appeler *Eriaporus aphelinoides*, est très voisine de *E. laticeps*; nous croyons cependant qu'on peut les distinguer de la manière suivante :

— Deux taches blanches séparées près de la base de l'abdomen ; pattes entièrement jaunes, seulement les hanches postérieures noires ; vertex et front jaune clair. .... *E. laticeps* Wat.

— Une bande transversale blanche à la base de l'abdomen ; pattes avec toutes les hanches et les fémurs noirâtres ; face aussi jaune, vertex un peu brunâtre. .... *E. aphelinoides* Comp.

L'espèce de Java, introduite en Egypte, est probablement parasite de *Leptomastix phenacocci* Comp.

Les deux autres espèces sont des Encyrtides et appartiennent toutes deux au genre *Achrysopophagus* Girault. Ce genre a été bien étudié par Mercet (1929) qui a décrit le *Achrys. aegyptiacus* Merc. et a donné une Table de détermination des espèces connues. Depuis lors aucune autre espèce n'a été décrite dans ce genre, mais Compere (1938) mentionne des formes africaines. Les deux espèces de Java sont considérées comme nouvelles.

Achrysopophagus javanicus sp. nov.

♀ : Corps tout noir, sans aucune partie jaune ou orangée, avec des reflets verdâtres ou bleuâtres sur le mesonotum, la face et les tempes, et violacés sur les mesopleures et le propodeum ; scutellum souvent vert, surtout brillant sur les côtés ; abdomen noir, les valves de la tarière jaunes, brunes à l'extrémité. Antennes avec le scape brun clair, blanc vers l'apex, le pédicelle et le flagelle brun-noir. Pattes brunes, les trochanters, la base des fémurs médians et tous les tarses blanchâtres. Ailes enfumées au milieu, hyalines à la base et sur une bordure terminale un peu plus large que le quart de la partie enfumée.

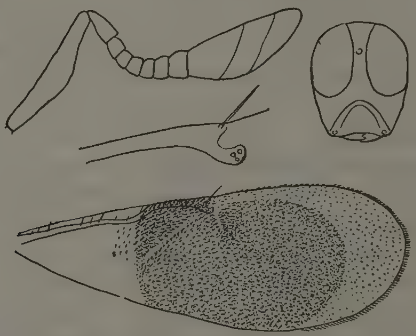


Fig. 1 : *Achrysopophagus javanicus* sp. nov., antenne, tête vue de face, nervures et aile.

Tête, vue de face, plus longue que large, ovale, le bord supérieur du sillon frontal atteignant le niveau du bord inférieur des yeux. Yeux grands, fronto-vertex étroit, allongé, les ocelles en triangle très aigu, l'ocelle médian situé au milieu du front, plus rapproché du bord des yeux que son propre diamètre. Antennes insérées sur les côtés de la bouche, scape peu élargi au milieu, dépassant de peu le sillon frontal, pédicelle presque deux fois plus long que large, presqu'aussi long que les trois articles suivants réunis ; les deux premiers articles du funicule subcarrés, les suivants un peu transverses, le 6e nettement plus grand que le 5e ; massue large, aussi longue ou plus

longue que le funicule. Thorax avec le mesonotum couvert de fins cils blancs serrés ; scutellum avec une ciliation blanche plus éparse et une touffe de cils noirs ; propodeum très étroit et lisse au milieu, élargi et chagriné sur les bords. Ailes grandes, nervure submarginale peu ondulée vers l'extrémité, nervure marginale longue, se terminant par une nervure stigmale courte et arrondie, nervure postmarginale courte, peu visible. Pattes antérieures avec les fémurs très élargis, à peine plus de deux fois plus longs que larges, les tibias aussi un peu élargis ; pattes médianes avec les tibias longs, l'éperon terminal aussi long que les deux premiers articles du tarse réunis. Abdomen triangulaire, plus court et plus étroit que le thorax ; tarière aussi longue ou un peu plus courte que la moitié de l'abdomen. Longueur 1.3-1.5 mm.

Java, Batavia. Décrit d'après 7 ♀♀, d'un lot introduit en Egypte en 1937.

D'après la Table de Mercet, cette espèce est voisine de *A. nigricornis* Girault et *A. aegyptiacus* Mercet. *A. nigricornis* obtenu de *Pseudococcus citri* aux Philippines est très imparfaitement décrit (1920). Cependant on peut relever les différences suivantes : chez cette espèce la tarière a « nearly 2/3 the length of the abdomen », la bande apicale des ailes est « much less broadly hyaline than in the preceding species » (*A. io*), où les ailes sont « infuscated as in *Cheiloneurus* », et les pattes sont foncées, avec seulement « the distal three tarsal joints of the middle legs which are silvery ». Chez *A. javanicus* la tarière n'est pas plus longue et généralement plus courte que la moitié de l'abdomen, la bordure hyaline de l'aile est aussi large ou plus large que chez la plupart des *Cheiloneurus* que nous connaissons, et les pattes ont tous les tarses entièrement blancs.

Le type de *A. aegyptiacus* Mercet, dans la collection Alfieri au Caire, a été examiné par le Dr. Priesner, qui m'a très aimablement donné les informations suivantes : chez *aegyptiacus*, la bordure hyaline des ailes est beaucoup plus étroite, la touffe de cils sur le scutellum est plus longue et les tarses médians ont les 2/3 du premier article et le dernier article noirs. D'après la description de Mercet, *aegyptiacus* a de plus le scape et le pédicelle plus étroits, les premiers articles du funicule plus longs que larges et le 6e article peu plus grand que le 5e. Compere (1938) décrit sous le nom de *A. aegyptiacus* deux « variétés » de l'Afrique du Sud et du Tanganyika. Il dit : « If it were not for a long series of intermediates in the collection of the University of California Citrus Experiment Station, it would be difficult to believe that the Stellenbosh and Bukoba specimens are specifically related or to identify either as *aegyptiacus* ». Il est possible que la coloration du corps et surtout des antennes soit très variable ; nous connaissons encore trop peu la variabilité de nombreux Encyrtides, qui ont été trop souvent décrits d'après un seul exemplaire. Mais en face de différences importantes, nous croyons préférable de décrire et nommer des

espèces, surtout si elles proviennent de régions différentes, et même si elles doivent être considérées plus tard comme des races géographiques d'autres espèces. En comparant les descriptions et figure de l'*A. aegyptiacus* Mercet d'Egypte et de l'*A. aegyptiacus* Compere de l'Afrique du Sud, nous avons peine à croire qu'il puisse vraiment s'agir de la même espèce, le bord hyalin de l'aile beaucoup plus étroit, la nervure marginale plus longue, le scape plus étroit, distinguant entr'autres le vrai *aegyptiacus*. *A. javanicus* se rapproche plus de l'*Achrysopophagus* de l'Afrique du Sud par l'infuscation des ailes, mais la nervure submarginale est moins ondulée, la nervure marginale est plus longue, les premiers articles du funicule sont plus courts, la tête est plus allongée et la coloration est différente.

Achrysopophagus annulatus sp. nov.

Tête jaune-orangé, avec de pâles reflets verdâtres sur les joues et les tempes et le vertex brunâtre. Thorax jaune-orangé avec une bande transversale verte sur presque la moitié postérieure du mesonotum et la touffe

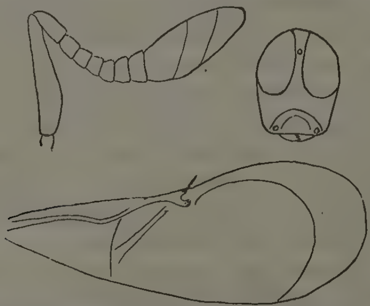


Fig. 2 : *Achrysopophagus annulatus* sp. nov., antenne, tête vue de face et aile (schématique).

de cils du scutellum noire. Abdomen entièrement noir avec des reflets verts et violacés et la tarière jaune clair. Antennes avec le scape jaune, blanchâtre à l'extrémité et étroitement brunâtre en dessous, le pédicelle brun, jaunâtre en dessous, les trois premiers articles du funicule bruns, le troisième un peu plus clair, les 4e et 5e articles blancs, le 6e et la massue noirs. Pattes entièrement jaune-clair, les tibias avec des lignes longitudinales brunes en dessus, les fémurs et tibias postérieurs légèrement brunâtres. Ailes enfumées au milieu, la bordure hyaline un peu plus large que le quart de la zone enfumée.

Tête, vue de face, nettement plus longue que large, les joues presque parallèles, la face très enfoncée, le sillon frontal régulièrement courbé, nettement plus bas que le niveau inférieur des yeux ; yeux grands, fronto-vertex très étroit, l'ocelle médian plus rapproché des bords des yeux que

son propre diamètre. Antennes insérées sur les côtés de la bouche, scape peu élargi au milieu, pédicelle deux fois plus long que large, le premier article du funicule subcarré, les suivants transverses et de plus en plus larges, le dernier environ deux fois plus large que le premier, massue moins large que chez l'espèce précédente, aussi longue que le funicule. Thorax chagriné, mat; un duvet de fins cils argentés recouvre la bande verte sur la moitié postérieure du mésonotum, scutellum avec des cils blancs épars et une assez forte touffe de cils; propodeum très étroit et lisse au milieu. Ailes avec la nervure submarginale ondulée avant l'extrémité, la nervure stigmale peu élargie. Pattes antérieures avec les fémurs ovales, environ trois à quatre fois plus longs que larges; éperon des tibias médians un peu plus long que le métatarse. Abdomen plus court et plus étroit que le thorax, triangulaire, la tarière aussi longue que la moitié de l'abdomen. Longueur 1.35 mm.

Java, Batavia, décrit d'après 1 ♀ introduite en Egypte.

Hôte : *Phenacoccus hirsutus*, probablement hyperparasite.

Cette espèce est caractérisée par la teinte jaune-orangée du corps, où seulement la bande transversale du mesonotum et l'abdomen sont verdâtres, par l'anneau blanc des antennes et par la tête allongée avec le sillon frontal très au dessous des yeux. D'après la Table de Mercet elle se rapproche de *A. oviductus* Gir. d'Australie, qui est jaune orangé avec le mesonotum, le propodeum et la base de l'abdomen verts et a seulement les deux premiers articles du funicule foncés. Elle est aussi voisine de *A. rex* Gir. des Philippines, chez qui les 5 premiers articles du funicule sont blancs, les valves de la tarière métalliques et le tiers postérieur du mesonotum verdâtre.

OUVRAGES MENTIONNÉS.

Compere, H. (1938) : A report on some miscellaneous African Encyrtidae in the British Museum (*Bull. Entom. Res.*, Vol. 29, pp. 315-337, 9 figs.).

Compere, H. (1939) : Description of a new species of *Leptomastix* parasitic in *Phenacoccus hirsutus* Green (*Bull. Soc. Fouad 1er Entom.*, (1938), pp. 36-38).

Compere, H. (1947) : A new genus and species, *Eurymyiocnema aphelinoides* (Hym. Aphel.) and a history of the genera *Euryischia* Riley and *Myiocnema* Ashmead (*Bull. Entom. Res.*, Vol. 38, pp. 381-388, 4 figs.).

Girault, A.A. (1920) : New Serphoid, Cynipoid and Chalcidoid Hymenoptera (*Proc. U.S. Nat. Mus.*, Vol. 58, pp. 177-216).

Mercet, R.G. (1929) : Los generos *Prochiloneurus* y *Achrysopophagus* (*Eos, Rev. Esp. Entom.*, T. 5, pp. 359-363, 2 figs.).

Waterston, J. (1917) : Notes on Coccid-infesting Chalcidoidea, III (*Bull. Entom. Res.*, Vol. 7, pp. 311-325, 7 figs.).

Morphological features as a means for detecting the different stages of the aphid *Myzus persicæ* Sulzer

[Hemiptera-Homoptera : Aphididae]

(with 7 Figures)

by A.A. SOLIMAN, B.Sc. (Hons.), M.Sc., Ph.D.,
Entomology Dept., Faculty of Science, Farouk I University.

INTRODUCTION

The green peach aphid, *Myzus persicae* Sulzer, is a cosmopolitan pest which is known to feed on a wide variety of plants. It is one of the commonest aphids in Egypt. Its host range has already been given by F. C. Willcocks (1922) and by W. J. Hall (1926).

As stated by Hall, this list can by no means be considered a complete survey of the variety of plants attacked by *Myzus persicae*.

Several of the attacked plants are subject to a number of virus diseases as has been reported by the Plant Pathology Section of the Ministry of Agriculture. This very fact brought to the author's attention the idea that this aphid might play a role in the transmission of some of those viruses.

For investigating the importance of each of the different stages of the vector in virus transmission a fair acquaintance with their morphological characteristics is necessary. Such a knowledge saves the time usually taken in rearing and watching such stages each time they are experimented with. It also makes it easier for the worker in transmission by rendering it possible for him to use individuals picked up from an ordinary growing aphid colony.

METHODS AND TECHNIQUE

Aphids were reared under leaf cages both in the field and green-house on potato leaves. During the breeding of the aphid several individuals (at least 10) of each stage were mounted in Diaphane. Then these were studied

and their characteristic features recorded. Camera lucida drawings were prepared for each of the various stages. Measurements of the different body structures were made in each case and are given further on.

GENERAL CONSIDERATIONS

The morphological features of *Myzus persicae* Sulzer are quite variable, more so than in most of the aphids. Characteristics which have been used as a means of distinguishing it from other species of the genus *Myzus* are here summarized :

(A) The usual form : Cornicles in length about equal to, or less than, the width of the head through the eyes. These cornicles may be either swollen in both alate and apterous viviparous females. The alate females have the forewings with veins not outlined with a fuscous border. The antennal tubercles are converging. This species is a medium size species usually with a dark dorsal abdominal patch on a lighter background. The apterous females are yellowish green forms and have cornicles longer than the width of the head across the eyes. The first antennal segment has its mesal margin protruding only slightly and is usually broadly and evenly rounded.

(B) Less common form : Cornicles not swollen. The fourth antennal segment has no secondary sensoria. The forewing with veins distinctly outlined wih fuscous margin. Primary sensoria on basal portion of the 6th. antennal segments conspicuously larger than the small surrounding sensoria, which are uniform in size. Cornicles not distinctly imbricated throughout. There is a dark dorsal abdominal patch on lighter background. Most of these characteristics referred to in the foregoing discussion appear in the accompanying figures.

LIFE-HISTORY

As a typical migratory aphid, *Myzus persicae* Sulzer, is known to appear in a number of different forms, each being limited to one particular season of the year. This fact led to a certain amount of confusion that appeared in the early literature concerning both the nomenclature and morphology of this species. Some of the forms in which this aphid appears have been mistaken by different authors as separate species, which later on proved to be nothing but phenotypes of the same species. The following is a list of synonymy according to Hottes and Frison (1931) :

Aphis persicae Sulzer : Abgekurzte Geschichte der Insecten nach dem Lineischen System (Winterthur, H. Steiner u. Co., II, 2, 1776, p. 105).

Rhopalosiphum tulipae Thomas, cotypes, Sauk City, Wisconsin (Davis, 1910).

Rhopalosiphum lactucellum Theobald (*Bull. Ent. Research* VI, p. 115 (1915) [Hall-1926]).

However, different seasonal forms that appear during the life-history of this aphid are now well known and are agreed upon by different authors, among whom are Taylor (1908) and Theobald (1926). Those forms are the following :

The egg-stage

Eggs are laid in the fall of the year in the axils of peach buds or of many other primary hosts typical for this species. These eggs winter over on this host which is known usually as the primary host. They hatch in the following spring to give rise to young stem mothers.

The stem mother stage

These are apterous viviparous females which produce several generations of wingless viviparous females. An interval of 15 or 17 to about 30 days, depending on temperature, elapses between the hatching of the egg to the birth of the first young of the stem mother.

Apterous female generations

These are quite similar in appearance to stem mothers. They may be produced on either primary or secondary hosts.

Winged viviparous female stage

These develop among the progeny of the stem mothers about May. They migrate to a secondary or alternate host and are known as the spring migrants. On the secondary host, which is systematically different from the primary one, the spring migrants establish themselves and produce a number of apterous generations.

Alate fall migrants

As a common occurrence the viviparous alate females that are produced on the secondary host in the latter part of the season migrate to the original primary host. On the primary host to which they have re-migrated, these viviparous females give rise to apterous oviparous females.

The sexual or oviparous females

This is an apterous insect which is produced on the primary host from the winged fall migrant, which migrated from the secondary host.

The alate males

These are produced on the secondary host by a viviparous generation of aphids. The male flies to the primary host to meet the sexual apterous female, where they mate.

After mating the females lay the eggs and the life cycle is repeated again.

The difference in morphology of the different forms may cause certain confusion in identifying this insect at its different stages of development, often occurring on a variety of primary and secondary hosts. Such confusion may be avoided by keeping in mind the characteristics for each form.

MORPHOLOGY

Myzus persicae Sulzer is known to occur in more than one morphological form as mentioned above. Therefore no one description will fit all of them. The adult forms which are recognized during the life cycle of this aphid are : the apterous stem mothers, the apterous viviparous females, the winged viviparous females which may be either spring or fall migrants, the oviparous females and the males. Descriptions of all these forms have been made by several authors, most technically by Gillette (1908a) and Theobald (1926). However, no one author has described the morphology of the various nymphal stages of this aphid.

In transmission work nymphal stages, adult wingless viviparous females as well as alate viviparous females are encountered. The work with these different forms necessitates a fair knowledge of their variation in appearance and characteristics. Thus this study will be devoted to a brief description of the morphology of only those forms which are usually used during transmission work. Before going into specific description of *Myzus persicae* Sulzer the characteristic features that separate aphids from the rest of the insect groups will be slightly touched upon here :

The division of the body of an aphid into three sections, the head, thorax and abdomen and the relation between these parts together with their appendages are similar to those in any typical insect. However, aphids deviate from the rest of the class Hexapoda in possessing the characteristic structures known as the cornicles. These take various forms in the different aphid groups and range from obscure structures which may be overlooked, or even considered absent in some cases, to huge structures which are the first thing that attracts the attention of the observer. The length and shape, as well as other features, of the cornicles are among the characteristics used consistently in classification. Other structures which are also of common use in aphid classification are the antennae, with their sensoria, the cauda, and the anal plate. With this in mind, the description of the different forms studied here will be presented.

Morphology of the adult aphid

The apterous adult female (Fig. 1)

The wingless adult female has a more or less oval body. The cauda is slightly protruding beyond the extent of the anal plate. The general color

of the body is yellowish green and on the whole darker than that of the nymphs. The eyes and the tarsal apices are black; the apices of the distal antennal segments and the tips of the cornicles are dusky. Young inside the female adult aphid generally show through the transparency of the body wall of the latter. The antenna is slightly shorter than the length of the body. The proximal lobe of the first antennal segment is gibbous. The relation between the different antennal segments and the structure in general can be grasped from a comparison of their lengths as indicated hereunder :

Antennal segments : I, 150 μ, basal lobe gibbous; II, 75 μ, carries no sensoria; III, 300 μ, carries no sensoria; IV, 300 μ, carries no sensoria; V, 210 μ; VI (a) basal segment, 120 μ, carries a sensorium at the tip of the base at attachment with filamentous part of the segment. (b) the ungus, 405 μ, shows constrictions; total antenna, 1560 μ, shorter than body. Body, 1800 μ, longer than antenna. Cornicle, 390 μ, shows no swelling (not swollen). Cauda, 165 μ, slightly elongated, more or less blunt; part of cauda beyond anal plate, 40 μ. Tibia of hind leg, 795 μ, carries no secondary sensoria. Rostrum, 275 μ, reaches to the anterior end of the second coxa.

The alate adult female (Figs. 2a and 2b)

The description given below fits either the spring or fall migrant with the exception of few minor details. Both these forms have the same features except that the cornicles of the spring forms are not swollen as are those of the fall migrants. In either case the body is more or less spindle-shaped. At first sight a winged aphid of the species *Myzus persicae* Sulzer appears black. However the insect is in fact deep green. The black appearance comes from the presence of dark brown to black shades on the head, thorax, and the transverse irregularly broken bands across the dorsal side of the abdomen. These dark brown to black patches, especially those on the thorax, form a definite pattern. The dusky nature of the wing veins, and the fact that the wings are held in a roof manner over the body, adds to the appearance of the predominat black pattern characterizing this aphid. Other parts that are dusky in color include the distal ends of the cornicles, the distal regions of all the femora, and the distal ends of all the tibiae. The nature and distribution of these blackish parts of the body add to the intensity and extensiveness of the dark brown to blackish mottling recognized at the first glance.

Measurements of the different body structures in a spring migrant aphid are given below :

Antennal segments : I, 150 μ, gibbous; II, 75 μ, stouter than in apterous females; III, 525 μ, with 12 to 13 circular sensoria distributed at nearly equal intervals on the outer margin of the segment; IV, 420 μ,

carries no sensoria; V, 315 μ, carries one apical sensorium; VI (a) basal segment, 150 μ, carries one sensorium at its junction with the ungus, (b) filamentous part (ungus), 525 μ, shows constrictions; total antenna, 2160 μ, about the same length of the body. Body, 2215 μ from tip of head to tip of cauda. Cauda, 180 μ, elongated; part of cauda extending beyond anal plate, 135 μ, with three hairs on each side. Cornicle, 360 μ, slightly swollen at its distal one-third, dusky at tip. Tibia of hind leg, 1275 μ, carries no sensoria. Rostrum, 480 μ, extends to mid-distance between the first and second coxae, about equidistant from both coxae I and II.

These measurements and characteristic features of the various parts show that the wingless and alate forms are widely different morphologically, and unless one is aware of the morphological changes that take place during the life-cycle of this insect, one is likely to be confused. A knowledge of these changes is fundamental, especially where migration of aphids comes into the picture. It is also needed to avoid mistaking the different forms of the one aphid for distinct varieties of the same species or even different species as it is commonly the case.

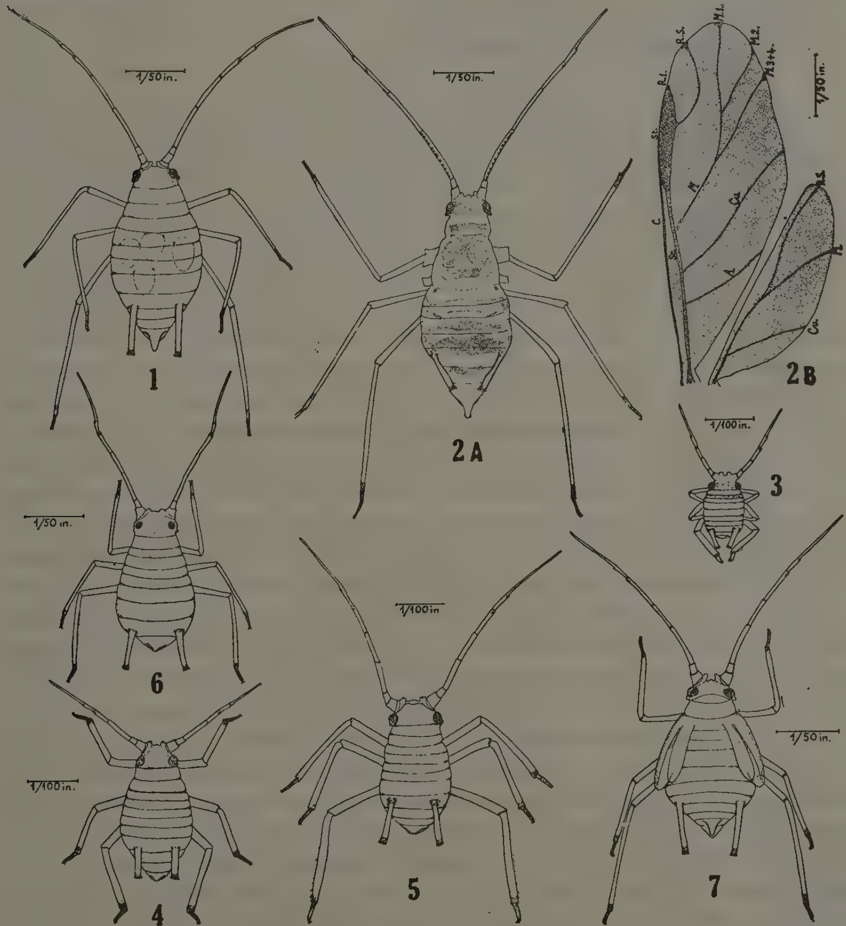
Morphology of the nymphal stages

The insect passes through five instars with four nymphal stages from the time it is born to the time it reaches maturity as an adult of either apterous or alate female stage. Each of these nymphal instars is of about two days duration at a temperature of about 75 to 80° F. after which it moults changing into the next stage. One more stage is known namely the nymphal stage with wing pads, called the pupal stage in the aphid literature. This stage develops in the alate form.

The short time required by the insect to reach maturity and the comparatively large number of young produced by a single female, together with the viviparous nature of the insect's parthenogenetic reproduction during the greater part of its life, make aphids in general a threat to crops at any time and in any part of the world where suitable environmental conditions prevail.

As is the case for almost all aphid species, the nymphal instars differ considerably in their morphology among themselves as well as from the adults. The main differences lie in the general shape of the body and the relation between its different parts. Although the morphological differences between the different nymphal instars may not warrant going into a description of each in detail, yet a fair knowledge of the characteristics of each is fundamental for any worker interested in transmission work. In transmission experiments there are certain occasions where the age of the stage used plays a considerable role in the results obtained. Once one becomes acquainted with the characters of each stage he will be able to pick up the

required stage with the aid of a hand lens or any other magnifying instrument and thus may be able to save considerable time in carrying on work of this nature. An alternative to this method of identification of the different aphid stages is that of rearing aphids and watching the stages through which they pass as carefully and closely as possible and then picking up the desired stage.



Myzus persicae Sulzer

Fig. 1 : Apterous adult female aphid, with the young showing through the transparency of the abdominal wall. — Fig. 2 (a) : Alate adult female, wings do not show in the drawing. — Fig. 2 (b) : The wings (right pair) of an adult alate female of the aphid, showing the veins. — Fig. 3 : The newly born first nymphal instar. — Fig. 4 : Second nymphal instar. — Fig. 5 : Third nymphal instar. — Fig. 6 : Fourth nymphal instar. — Fig. 7 : A wing-padded nymph, which later develops into an alate female.

Needless to say that the detection of stages on the basis of their morphology is an accurate and time-saving technique.

In the following section a brief description of the main features of the different stages is presented. These descriptions though might not be quite complete yet can be considered as a starting point for a detailed work along this line planned for the future. In their present form those descriptions proved to be of great use for separating the various nymphal stages as usually done in transmission experiments.

The first nymphal instar (Fig. 3)

The insect when newly born is a pale yellow or rather whitish tiny creature capable of crawling on the surface of the plant leaf and soon inserts its rostrum in the tissues of the plant. The body of the insect at this stage is more or less rectangular with the abdomen slightly broader than the thorax, especially at its posterior end. Although the insect is then seen easily by the naked eye, its detailed features cannot be revealed except by the aid of a magnifying instrument. Most of the structures of the mature insect body are not fully developed in the nymph. However, both the rostrum and the cornicles are developed to an extent that strikes the observer's eye at first sight. The antenna is here five-segmented, with the distal or the fifth provided with the filament-like structure, or ungus. This segment always remains the terminal one, regardless of development of additional antennal segments in the following nymphal instars. At the place where the ungus joins the basal part of the segment, the latter possesses a sensorium which together with the sensorium at the tip of the fourth segment is the only noticeable one found on the antenna at this stage. The ungus is here more or less even in thickness throughout. The eyes occupy the same position as those of the adult but they lack the ocular tubercles. The legs are stout and short when compared with those of later stages. The cauda shows no signs of elongation as yet. Following are the relative lengths of the different parts of the body of a newly-born nymph :

Antennal segments : I, 45 μ, the gibbous nature is not yet detectable; II, 30 μ; III, 75 μ, carries no sensoria; IV, 60 μ, carries a primary sensorium at distal end; V (a) basal region, 60 μ, carries a sensorium at tip, (b) ungus, 185 μ, has the same thickness throughout; total antenna, 495 μ, longer than the body. Body, 420 μ, shorter than the antenna. Cornicle, 120 μ, not swollen. Cauda, 15 μ, bluntly triangular. Tibia of hind leg, 210 μ. Rostrum, 230 μ, reaches just behind the extent of coxa III.

The second nymphal instar (Fig. 4)

By this stage the insect has changed considerably in the general form of the body, being now more elongated than in the previous stage. The color

is now more or less greenish-yellow. The antenna is five-segmented, and the segments bear a relation to each other which is different from that they possessed before. The cauda is still blunt at the present stage and the cornicles are not swollen. The eyes still lack the ocular tubercles. The proportions of the body parts can be compareed from the following figures which give the length of different structures :

Antennal segments : I, 90 μ, gibbous nature already slightly shown ; II, 60 μ ; III, 195 μ, carries no secondary sensoria ; IV, 105 μ, with an apical primary sensorium ; V (a) basal part, 75 μ, with a sensorium at its junction with ungus, (b) ungus, 270 μ ; total antenna, 795 μ, about two thirds the body length. Body, 1050 μ, longer than antenna. Corniche, 180 μ, dusky tip. Cauda, 75 μ, blunt. Tibia of hind leg, 420 μ. Rostrum (beak), 375 μ, tip reaches the base of the second coxa.

The nymph at this stage may be equal in physical size to the late first or early third nymphal stages, but the striking differences in morphological characteristics of each of these make their separation quite easy.

The third nymphal instar (Fig. 5)

By the third nymphal stage, the insect has acquired most of the adult features. The antenna has already its characteristic six segments, with the third not yet in its complete form. The ocular tubercles are only slightly projecting. The cornicles show no swelling at the present stage. The cauda is also still in a primitive form and is not elongated as it will appear later in the adult stage. This stage in the life-history of the insect differs from the preceding two stages as far as the color of the body is concerned. Here the body has already acquired a greenish yellow appearance with a very few dusky spots limited to the apices of the tarsi, apices of the two distal antennal segments, and the tips of the cornicles. Except for these, the body shows no other mottling.

More information about the body regions can be obtained from the following measurements and characteristics of the various structures :

Antennal segments : I, 105 μ, (a) basal part, 45 μ, gibbous nature already appears, (b) distal part, 60 μ ; II, 60 μ ; III, 165 μ, carries no secondary sensoria ; IV, 195 μ ; V, 165 μ, carries one distal primary sensorium ; VI, (a) basal portion, 90 μ, with a sensorium at tip, (b) ungus, 375 μ ; total antenna, 1260 μ, longer than the body. Body 1050 μ, shorter than antenna. Cornicle, 255 μ, not swollen. Tibia of hind leg, 550 μ. Cauda, 60 μ. Rostrum, 570 μ, tip dusky, reaches up to coxa III.

The fourth nymphal instar (Fig. 6)

By this stage the nymph has moulted three times, and still has only one moult to undergo to become an apterous adult female. At the present

stage the insect has already acquired most of the features characteristic of the adult apterous female insect. It has also the same appearance as well as the body markings of the apterous adult. However, the antenna here has not yet attained its final length and lacks the secondary sensoria. Similarly the cauda is still blunt or has not yet elongated to the same extent as that of the adult.

The characteristics of the different body regions at the present stage can be grasped from the following figures, in which they are included :

Antennal segments : I, 105 μ, distinctly gibbous ; II, 60 μ ; III, 285 μ, carries no secondary sensoria ; IV, 240 μ, carries no secondary sensoria ; V, 225 μ, carries a distal primary sensorium ; VI (a) basal part, 105 μ, with a distal sensorium at its attachment to the filamentous part, (b) ungus, 480 μ ; total antenna, 1500 μ, longer than the body. Body, 1350 μ, shorter than the antenna. Cornicle, 360 μ, not swollen. Cauda, 45 μ, blunt, not yet elongated. Tibia of hind leg, 750 μ. Rostrum, 450 μ, extends to the posterior level of coxa II, tip dusky.

The pupal stage, the wing-padded nymph (Fig. 7)

Those nymphs that give rise to the alate adults are known to possess wing pads and are called the pupae in the aphid literature. The development of a nymph of this type is of a relatively longer duration than in the ordinary nymphs, as it usually lives for more than one week. It undergoes one moult after which it becomes an adult alate aphid. As in the case of every other nymphal instar, the size of the pupal stage of aphids varies with age. Furthermore, due to the comparatively long duration of this particular stage, the variation is quite noticeable. However, the ratio between the different body parts is about the same as in all of the nymphal cases. This ratio seems to be more or less constant. Information illustrating the relation that exists between the different parts is presented below.

At this stage the antenna has reached its complete development except that it still lacks the secondary sensoria that are known to exist on the third antennal segment in the adult alate aphid. The eyes possess well developed ocular tubercles. The wing pads that characterize this stage extend backwards to about half the length of the abdomen. The cauda is elongated and the cornicles are slightly swollen. Apices of tibiae, cornicles, and rostrum are dusky in appearance. These and several other characteristic features are summarized hereunder :

Antennal segments : I, 120 μ, gibbous at the base ; II, 45 μ ; III, 330 μ, carries no secondary sensoria ; IV, 300 μ ; V, 225 μ, with a distal primary sensorium ; VI (a) basal segment, 105 μ, with distal sensorium, (b) filament (ungus), 480 μ ; total antenna, 1605 μ, shorter than body. Body, 2220 μ, longer than antenna. Cornicle, 360 μ, slightly swollen at lower

one-third. Cauda, 180 μ, elongated. Tibia of hind leg, 885 μ. Rostrum (beak), 325 μ, tip dusky, reaches anterior level of coxa II. Wing pads, 750 μ, extend to half the abdomen.

SUMMARY

The morphology of the adult apterous and alate viviparous females of the aphid, *Myzus persicae* Sulzer, was discussed. A study of the morphological characteristics of each of the nymphal stages of this aphid was also presented.

This study was done for the purpose of presenting a new method for the differentiation of the various stages used in transmission work to replace the ordinary tire-some and time-consuming rearing method.

Measurements of the structures of the body that are important in classification have been recorded. The obvious differences between the different structures at different nymphal stages warrant considering this method a valid one as a means for detecting the nymphal stages of this and other aphids.

ACKNOWLEDGMENTS

I wish first of all to express my gratitude to Prof. Dr. A.A. Granovsky, of the Entomology Dept., University of Minnesota, U.S.A., whose sincere help and advice during the course of this study made it possible.

Thanks are also due to Dr. Mohamed Kamal Bey, Professor of Entomology, Faculty of Science, Farouk I University, for his help and encouragement in preparing this study.

LITERATURE CITED

Davis, J.J. (1910) : A list of the Aphididae of Illinois with notes on some of the species (*J. Ec. Ent.* V, 3, pp. 407-482).

Gillette, C.P. (1908) : Notes and description of some orchard plant lice of the family Aphididae (*J. Ec. Ent.*, V, 1, pp. 302, 359).

Hall, W.J. (1926) : Notes on the Aphididae of Egypt (Bull. No. 68, Technical and Scientific Service, Ministry of Agriculture, Egypt, 62 pages).

Hottes, F.C., and Frison, T.H. (1931) : The plant lice or Aphididae of Illinois (State of Illinois Dept. of Reg. and Ed., Div. of Nat Hist., Survey Bull. No. 19, Article 3, pp. 121-447).

Taylor, E.P. (1908) : Life history notes and control of the green peach aphid (*J. Ec. Ent.* V, 1, pp. 83-91).

Theobald, F.V. (1915) : African Aphididae, II (*Bull. Ent. Res.* VI, 115).

Theobald, F. V. (1926) : The plant lice or Aphididae of Great Britain (Headley Bros., London).

Willcocks, F.C. (1922) : A survey of the more important Economic insects and mites of Egypt (Bull. No. 1, Technical Section, Sultanic Agricultural Society, Cairo).

Biological control projects in Egypt, with a list of introduced parasites and predators

by Dr. Mohamed Kamal Bey,
Professor of Entomology, Faculty of Science, Farouk I University

INTRODUCTION

Before proceeding to discuss the various projects of biological control initiated in Egypt under the writer's direction, it may be useful to give a historical review of the attempts carried out by my predecessors in this field.

The first attempt on record to utilize the natural enemies against insect pests in Egypt dates back to 1890-1892, when C.V. Riley took the charge of forwarding consignments of *Rodalia cardinalis* Muls. to rear-admiral R.N. Bloomfield, Director General of the Ports and Light-houses in Alexandria. The shipment, which arrived at Alexandria in good condition on March the 20th 1892, was originally dispatched from Los Angeles by Coquillet. The writer was unable to secure any information about the outcome of that importation. In 1902, however, F.C. Willcocks, then Entomologist of the Khedivial Agricultural Society, made another attempt to introduce the beetle into Egypt from California, to combat the cottony-cushion mealy-bug, *Icerya purchasi* Mask., which was at that time a serious pest in Cairo and vicinity. That introduction was successful, and the beneficial beetle had become established, and is now common all over the country.

The increasing reputation of *Cryptolaemus montrouzieri* Muls. in California as an efficient predator against the citrus mealy-bug, *Pseudococcus citri* (Risso), encouraged Willcocks (chief entomologist of the Khedivial Agricultural Society), in 1909, to contact Froggatt in Australia to send him a consignment of the beetles to Egypt, but all the specimens in the shipment perished en route.

That same year, the Khedivial Agricultural Society also attempted to introduce a Braconid wasp (*Microbracon lefroyi* Dudgeon and Gough), which

was reported to parasitize the Spiny Bollworm in India. The material was shipped by Professor Maxwell Lefroy, and arrived in 1910. Unfortunately, the consignment contained no living parasites.

An importation of *Calosoma inquisitor* L., *Calosoma sycophanta* L., and *Carabus* spp. (Coleoptera : Carabidae), to prey upon *Prodenia litura* larvae, occured in 1912 when the Khedivial Agricultural Society delegated Mr. A. Andres to Germany for this purpose. The introduction was a complete failure.

A further attempt to introduce *Microbracon lefroyi* was made in 1912. The Khedivial Agricultural Society delegated Mr. A. Alfieri to India, to collect and bring back living specimens. About the same time Dr. Lewis H. Gough, entomologist to the Egyptian Department of Agriculture, went to India for the same purpose. Both parties brought back living *Microbracon*, but the colonies died out before they could be released in the fields.

In 1922, C.B. Williams, the Director of the Entomological Section at Cairo, made the second attempt to introduce the *Cryptolaemus montrouzieri* Muls. As this beneficial Coccinellid beetle was introduced by the French entomologists to fight the mealy-bugs in the French Riviera, consignments were sent from there to Egypt for the purpose of combatting the sugar-cane mealy-bug, *Pseudococcus sacchari* Ckll. The beetles did not reproduce in confinement and, therefore, Mr. Williams had to try again in 1923 the introduction directly from California.

In 1926, the first insectary devoted particularly for mass production of this predator was established, and Abd El-Megid El-Mistikawy was appointed in charge of the work.

RECENT ADVANCES

The end of the year 1927, really marks the beginning of biological control on a broad scientific basis in Egypt. It was the time when the author returned home from a scientific scholarship mission spent mostly in the University of California. A great part of his entomological studies was devoted to research work in biological control at Riverside under the leadership of Prof. H.S. Smith, with Compere and Timberlake as supervisors and consultants.

The publishing of Mr. T.W. Kirkpatrick about the efficiency of the parasite *Microbracon kirkpatricki* Wilk. in Kenya Colony as being able to kill nearly 80% of the population of the Pink Bollworm (*Pectinophora gossypiella* (Saund)) there, enthused C.B. Williams to attempt to introduce the parasite into Egypt, in hopes to reduce the damage done by that pest in the summer. Therefore, an expedition was outlined to the colony in October 1927, and Mr. Alfieri was put in charge. He succeeded in

sending, in the earlier months of 1928, several consignments of parasitized cotton bolls in specially devised wooden boxes kept in cold storage of steamers heading to Suez. The author was appointed in charge, and a temporary laboratory was established at Suez, in January 1928, to handle the consignments as soon as they arrived. Strict quarantine measures were taken to guard against ingression of any insect introducers or hyperparasites.

By recovering an appreciable number of live parasites, and by developing an appropriate technique for breeding, the laboratory at Suez was shifted from that arid zone in 1929 to a locality near the coast, where cotton is extensively grown and climatic conditions are favourable. Mandara, about 10 miles to the north of Alexandria, was chosen because of its climatic conditions which conveniently favor the development and establishment of the parasite.

In 1929, plans have been submitted by the author for the establishment of a laboratory at Giza, especially adapted to biological control work. About the end of the same year, the laboratory was inaugurated by Mr. Ballard, Chief Entomologist of the Ministry of Agriculture. For the purpose of equipping our modern laboratory, the writer was sent to England for a mission which lasted for few months to study the organization and development of research in the parasite laboratory at Farnham Royal, under the supervision of Dr. W.R. Thompson, the eminent biological control worker.

In 1932, a comprehensive report was submitted by the writer to the chief entomologist. That report embodied plans and policies for the undertaking of the principal biological control projects in Egypt, and outlined the means and measures for tackling such problems. Since then, extensive work concerning different aspects of biological or natural control of our most important insect pests has been established.

The author was, however, successful in his attempts to introduce *Microbracon lefroyi* from the Punjab, India, in November 1934. At that time, the Pink Bollworm, *Pectinophora gossypiella* Saunders, was the serious host. Air transportation was also established between our two respective countries. Another attempt was made by the author in August 1935, which resulted in the introduction of a total number of 69 live parasites in which the number of females was less than one-fourth. The outcome of the last two shipments culminated in the production of large breeding stock in the laboratory. During the biological studies of the species, it was found to be a variety of our local species, *Microbracon brevicornis* Wesm., as they crossed together very freely to such an extent that made it so difficult ot separate the two species.

RESEARCH PROJECTS AND RESULTS ACHIEVED

The control of the Pink Bollworm

The control of the Pink Bollworm (*Pectinophora gossypiella* Saunders) in Egypt is considered to be the most important project due to the extensive damages the pest is capable of producing to the quality and quantity of the staple crop of Egypt. The project was started by conducting extensive control experiments by the use of the Kenya parasite, *Microbracon kirkpatricki*. Search for other parasites of the Pink Bollworm has extended to countries which are supposed to be the original home of the pest, such as India, the Malay peninsula and the Dutch East Indies. Other parasites were also sought in other countries such as U.S.A., Brazil, Mexico, China, West Indies Islands and South Africa.

Some of the introduced parasites were acclimatized in Egypt and were found to kill a small ratio of the Pink Bollworm, which although not high, was quite effective in reducing the population of the worms present in the cotton fields, especially at the close of the season when the infestation in the unpicked bolls reached its peak.

Attention was also focussed on the study of the local parasites about which very little was known so far. The purpose of the study is to determine the species of parasites and their host relationships and the importance of each species as a controlling agent. Studies were also carried out in order to learn about the behaviour, breeding methods and the factors that limit their activities. The results achieved in this direction are quite interesting, since several unknown phases of this problem have been exposed. These studies revealed also the kind of inter-relationships existing between some of the important parasites, such as *Microbracon kirkpatricki*, *Microbracon brevicornis* Wesm., etc., which attack both the Pink Bollworm and are capable of checking to some extent its damages, especially at the hibernation period when the larva enters in the resting stage in double seeds on neglected cotton sticks.

Considerable cooperation between our institution and those of other countries, made it possible to exchange several of the beneficial insects that attack the boll worms. Methods of shipping, techniques, and research work along this line were formulated to the best advantage. Such cooperation resulted in sending four species of Egyptian parasites to the cotton planting areas in Texas; while two new parasites in exchange were introduced into Egypt. World war and the restrictions imposed on exchange of parcels, interferred into the progress of that work and stopped plans for the introduction of newly found Pink Bollworm parasites from Tanganika, South Africa, Belgian Congo, Uganda, West Indies and America.

The control of mealy-bugs

The chief mealy-bugs of great economic importance in Egypt are the Hibiscus mealy-bug (*Phenacoccus hirsutus* Green), the Citrus mealy-bug (*Pseudococcus citri* Risso), the Lebbek mealy-bug (*Pseudococcus filamentosus* Ckll.), and the Sugar-cane mealy-bug (*Pseudococcus sacchari* Ckll.).

The biological control measures that were used in combatting these mealy-bugs in Egypt since 1926 were confined in the use of *Cryptolaemus montrouzieri* Muls., which was reared and distributed for that purpose. The outbreaks all over the country to threaten the cotton plantations as well as the orchards, called for an immediate consideration of biological control work other than the use of that very slow and expensive method, the *Cryptolaemus* and the application of oil sprays.

The predaceous Coccinellid beetle, *Cryptolaemus montrouzieri* Muls., was reared and distributed on a limited scale due to the considerable time and care the insect requires. Although, it succeeded in Egypt in becoming established, yet due to its low reproductive potential slow spreading, the necessary protection to stand our winter conditions, and the annual release of new colonies, the work on it was abandoned. The insect feeds freely on various kinds of mealy-bugs but the expenses involved in continuous breeding and feeding of the beetle made the project a very costy one.

The Batavia parasites

Since the home of the Hibiscus mealy-bug was known to be India and the Far East in general, searching for parasites of the pest was concentrated in countries where reliable information of the status of the pest was secured. For this purpose, contacts between the Egyptian parasite laboratory and the research institutes of other counries such as India, Dutch East Indies, Morus Research Laboratories at China, have been established. As a result of such contacts, the first attempt for the importation of mealy-bug parasites from Batavia started about the end of 1933, was not encouraging.

From Batavia, more news were received that a parasite was found to parasitize the same species of mealy-bug that existed in Egypt and caused considerable reduction in the population of the pest. Consignments of this unknown species of parasites were shipped from there to Giza in 1934. Later consignments led to the discovery of four beneficial species of endoparasitic hymenoptera that belong to the family Encyrtidae. Two of them were identified by Compere and Ferrière as *Leptomastix phenacocci* Compere and *Achrysopophagus* spec., while Moursi described the two others as *Anagyrus kamali* and *Anagyrus aegyptiacus*. The chief among the predators in *Scymnus conformis* Jord. (Coccinellidae).

In 1936-1939, other introductions were made to augment the number of parasites at hand, and the results attained were quite satisfactory.

At some localities (Giza and Menufia Provinces), the beneficial insects were released from 1934-1939, and our records indicated that the releases were able to wipe out heavy infestations. It was quite difficult to find any unparasitized mealy-bugs during the years 1935-1936 in the two provinces.

Our usual procedure was to collect and release the parasites on new localities all over Egypt from the Mediterranean coast to Aswan. Since that time, the Hibiscus and the Lebbek mealy-bugs decreased considerably in intensity of infestation, and in many localities they disappeared almost completely. The degree of parasitism among the mealy-bugs reached quite often as high as 98%. The parasite species, *Anagyrus aegyptiacus* Moursi and *Leptomastix phenacocci* Compere, succeeded in parasitising the Lebbek mealy-bug, *Pseudococcus filamentosus* Ckll. For this reason, the parasites were distributed in places where the infestation seriously endangered the great shade tree of Egypt known eversince Pharaonic times. Through these successful efforts the trees were saved from destruction and annihilation. The condition of the trees have now improved considerably and the infestation was decreased to a marked extent.

Exochomus melanocephalus Zoub. (=*nigromaculatus* Goeze), a predaceous Coccinellid beetle which was introduced into Egypt from South Africa, is reported to be able of destroying the Citrus mealy-bug, *Pseudococcus citri* Risso. It succeeded also in feeding upon the Sugar-cane mealy-bug and several aphid species. Trials have been made to breed the predator for acclimatisation in Egypt. About 3500 adult insects as well as 4000 egg-masses of this species were distributed on Sugar-cane mealy-bug and aphid infestations at Giza and the Barrage and the results were encouraging in reducing the infestation but not permanent.

Enemies of the fluted scale

The *Rodalia cardinalis* Muls. is recognised to be the most useful predator against *Icerya purchasi* Mask., one of the worst citrus grove pests. It is also a serious pest on many ornamentals. There is another species namely, *Icerya aegyptiaca* Douglas, which attacks our shade trees and causes considerable damage to them.

The *Rodalia* preys upon both species and does good work where it is found in large numbers.

An internal dipterous parasite, *Cryptochaetum iceryaea* Will., which is known to destroy the internal organs of its host, was introduced from California. To this parasite is attributed the success met with in destroying the fluted scale in humid places close to the sea shore where climatic con-

ditions suit the development of the pests. This parasite has been distributed chiefly in the Alexandria district and the preliminary results have been most encouraging. It remains to be known whether the parasite has been acclimatized in Egypt or not.

The control of the Sugar-cane mealy-bug

In 1938 a very popular Chalcid parasite known as *Pseudococcobius terryi* Fullaway, imported from South America into the U.S.A., appeared in the sugar-cane plantations to be doing marvellous work in reducing infestations by the pest. It destroyed the Sugar-cane mealy-bug to such a degree that saved the extensive sugar-cane plantations from destruction. In 1939, contacts with the specialists there to introduce the parasite in Egypt were started, but on account of the second World War conditions the project was postponed.

The control of the Cotton leaf-worm

Research work concerning the biological control studies of *Prodenia litura* F., is being published separately in this Bulletin.

The control of the Woolly apple aphis

Of the projects which have been thoroughly investigated is that of introducing the parasite known as *Aphelinus mali* Hold. which attacks the Woolly apple aphis, *Erisoma lanigera* Hausm., which is a destructive pest on apples in Upper-Egypt. This useful parasite was introduced from England and became acclimatized in the apple orchards of Assiut, Girga, and Minya Provinces. It is now doing excellent work in reducing the damages done by the pest.

The control of the Mediterranean fruit-fly

Through the help and courtesy of the Bureau of Entomology, U.S. Dept. Agric., it was possible for the author to introduce into Egypt the most important species of parasites attacking the fruit-fly in the Hawaiian Islands. Italian and Spanish entomologists have tried long time before us to introduce these parasites in view of controlling the Mediterranean fruit-fly, *Ceratitis capitata* Wied., but their efforts met with no success. However, our trials in this respect have succeeded in establishing two species. The most important of the two is a Braconid fly, *Opius humilis* Silv., which was recovered from the liberated zone at the Barrage two years after the initial release and disappeared ever since. The other and less important is the Tetrastichnid fly *Tetrastichus giffardianus* Silv., which has become established and shipments of which have been sent to both Spain and Cyprus.

The control of the Cotton thrips

Cotton thrips, *Thrips tabaci* Lind., is one of the most dangerous pests on cotton in the Northern Delta. Recently, an important beneficial Eulophid, *Dasyscapus parvipennis* Gah., was found to parasitise the pest in the Gold Coast Colony. Consignments of the parasite have been sent to the West Indies and brought about successful results in controlling the pest. Since the Cotton thrips in Egypt is known to be free from parasite attacks, it occurred to the writer to attempt to introduce *Dasyscapus parvipennis*. The introduction was tried twice in 1938 and 1939, respecively; but, unfortunately, it was not possible to obtain the parasite alive. The first consignment was sent by mistake to England and relayed to us, while the second due to interruption of transportation due to the second World War was held for a long time en route, and thus reached us dead. For these reasons the project was suspended for future occasions.

The control of the European corn borer

The damage done by the European corn borer, *Pyrausta nubilalis* Hb., in Egypt is increasing considerably year after another. The pest threatens the vast plantations of corn, which is the staple food for the Egyptian peasants. The United States Government spares no effort and spends millions of dollars annually for its control. Special laboratories have been established for the introduction of the natural parasites from Europe, the original home of the pest. In Egypt, a complete program for studying the biology of the pest has been prepared by the Entomological Section of the Ministry of Agriculture, and a project for its biological control has been outlined by the author. The breaking up of hostilities in Europe which resulted in the second World War stopped our endeavors and resulted in postponement of the investigation.

The control of the Black scale

Due to the extensive infestation of the Citrus groves in Egypt by two of the most important citrus pests, *Chrysomphalus ficus* Ashm. (=*aonidum* auct.) or the Black Scale, and *Aonidiella aurantii* Mask. or the Red scale, the Chalcid parasite *Comperiella bifasciata* How., was introduced by the author from California.

Attempts to propagate the parasite on our scale species have failed. The parasite did parasitize our local species but was unable to produce progeny due perhaps to the reduced fecundity of the parasite. The unsuitability of the scale as a developmental medium for the parasite may be due to something lacking or possessed in the host species. It is also very likely that the plant on which the host insect breeds may also be involved in this respect.

Similar experience has been met with in experimenting with this parasite when first introduced into California from China.

More recent attempts to re-introduce the parasite from California was successful. The parasite Laboratory is breeding the Black scale in large numbers on ordinary pumkin. The results of the last trials will be published in details by the Parasite Laboratory.

CHRONOLOGICAL LIST
OF THE BENEFICIAL INSECTS INTRODUCED IN EGYPT

1890-1892. — *Rodalia cardinalis* Muls. (Coleoptera : Coccinellidae).

Imported from California (Bureau of Entomology in Washington).

Host : *Icerya purchasi* Mask. (Hemiptera-Homoptera : Coccidea).

Liberated all over Egypt. Well established, efficient, feeds also on *Icerya aegyptiaca* Douglas.

1909. — *Microbracon lefroyi* Dudgeon and Gough (Hymenoptera : Braconidae).

Introduced from India. The material was shipped by Professor Maxwell Lefroy, and reached the Khedivial Agricultural Society in 1910. All parasites died during the journey.

Host : *Earias insulana* Boisd. (Lepidoptera : Agrotidae-Acontiinae).

1912 (August). — *Calosoma inquisitor* L., *Calosoma sycophanta* L., and *Carabus* spp. (Coleoptera : Carabidae).

Introduced from Germany by the Khedivial Agricultural Society, to prey upon *Prodenia litura* F. larvae and pupae.

All samples died en route.

1912 (October and November). — *Microbracon lefroyi* Dudgeon and Gough (Hymenoptera : Braconidae).

Imported from India by the Department of Agriculture (Cairo), and by the Khedivial Agricultural Society.

Host : *Earias insulana* Boisd. (Lepidoptera : Agrotidae-Acontiinae).

All died before liberation.

1922 (July). — *Cryptolaemus montrouzieri* Muls. (Coleoptera : Coccinellidae).

Obtained from France by the Entomological Section of the Ministry of Agriculture (Cairo).

Hosts : *Pseudococcus filamentosus* Ckll., *Pseudococcus sacchari* Ckll., and *Phenacoccus hirsutus* Green (Hemiptera-Homoptera : Coccidae).

Liberated all over Egypt. It has to be recolonised each year; field protection is necessary in winter.

1928 (January and February) and 1931 (March). — *Microbracon kirkpatricki* Wilk. (Hymenoptera : Braconidae).

Imported from Malindi and Mambrui (Kenua Colony, British East Africa), in 1928, and from Sudan in 1931.

Host : *Pectinophora gossypiella* Saunders (Lepidoptera : Gelechiidae).

Liberated nearly all over Egypt. It was recovered in winter from specimens of dry bolls left on cotton sticks two years after the first release.

1931 (March, October and November). — *Trichogramma minutum* Riley (Hymenoptera : Trichogrammatidae).

Obtained from the Imperial Institute of Entomology Farnham Laboratory, England.

Hosts : *Pectinophora gossypiella* Saund. (Lepidoptera : Gelechiidae), and *Earias insulana* Boisd. (Lepidoptera : Agrotidae-Acontiinae).

The parasites were liberated at Giza against the eggs of the Pink Bollworm, and gave partial control. The species crossed with our indigenous *Trichogramma evanescens* Westw.

1932 (March). — *Aphelinus mali* Hald. (Hymenoptera : Aphelinidae).

Host : *Eriosoma lanigera* (Hausm.) (Hemiptera : Aphididae).

Liberated at Assiut and Minya. The parasite is established and doing excellent work.

1933 (August and September). — *Anagyrus* spec. (Hymenoptera : Encyrtidae).

Introduced from Batavia, Java (Institute of plant diseases, Buitenzorg).

Hosts : *Pseudococcus filamentosus* Ckll., and *Phenacoccus hirsutus* Green (Hemiptera-Homoptera : Coccidae).

The parasites arrived dead.

1934 (March and May). — *Aphelinus mali* (Hald.) (Hymenoptera : Aphelinidae).

Obtained from the Imperial Institute of Entomology Farham Laboratory, England.

Host : *Eriosoma lanigera* Hausm. (Hemiptera-Homoptera : Coccidae).

Liberated at Mallawi (Assiut Province, Upper-Egypt).

From the two consignments a strong colony was recovered and released, the parasite has become established and does excellent work in the apple orchards.

1934 (August and September). — *Anagyrus kamali* Moursi, *Anagyrus aegyptiacus* Moursi, and *Leptomastix phenacocci* Compere (Hymenoptera : Encyrtidae).

Imported from Java (Institute of plant diseases, Buitenzorg).

Hosts : *Pseudococcus filamentosus* Ckll., and *Phenacoccus hirsutus* Green (Hemiptera-Homoptera : Coccidae).

Liberated at Giza and at Kobba gardens. Few individuals of each species were recovered and released on shade trees.

1934 (October). — *Comperiella bifasciata* How. (Hymenoptera : Encyrtidae).

Obtained from the Citrus Experimental Station, Riverside, California, U.S. America.

Host : *Chrysomphalus ficus* Riley (Hemiptera-Homoptera : Coccidae).

Liberated at Giza. Was unable to reproduce on our scale insects attacking Citrus and *Ficus* trees.

1934 (November). — *Microbracon lefroyi* Dudgeon and Gough (Hymenoptera : Braconidae).

Obtained from the Government Entomologist, Lyalpur, Punjab, India.

Hosts : *Pectinophora gossypiella* Saunders (Lepidoptera : Gelechiidae), and *Earias insulana* Boisd. (Lepidoptera : Agrotidae-Acontiinae).

The parasites were used for breeding purposes and no liberation was made.

1934 (December). — *Opius humilis* Silv. and *Diachasma tryoni* Cam. (Hymenoptera : Braconidae), and *Tetrastichus giffardianus* Silv. (Hymenoptera : Eulophidae-Tetrastichinae).

Obtained from the Bureau of Entomology, Hawaii.

Host : *Ceratitis capitata* Wied. (Diptera : Trypaneidae).

All died en route, because the shipment was sent by boat across the Pacific to Suez.

1935 (April). — *Cryptochaetum iceryae* Will. (Diptera : Cryptochaetidae).

Received from the Citrus Experimental Station, Riverside, California, U.S. America.

Host : *Icerya purchasi* Mask. (Hemiptera-Homoptera : Coccidae).

Liberated around Cairo, Giza, and Alexandria.

The parasite was recovered six months after liberation in the Alexandria region, and the pest is now rare there.

1935 (June). — *Microbracon mellitor* Say (Hymenoptera : Braconidae).

Received from the Bureau of Entomology Parasite Laboratory, Hawaii.

Host : *Pectinophora gossypiella* Saunders (Lepidoptera : Gelechiidae).

Liberated in most Provinces, especially in Lower-Egypt.

Not established, still bred in laboratory.

1935 (June). — *Opius humilis* Silv. and *Diachasma tryoni* Cam. (Hymenoptera : Braconidae), and *Tetrastichus giffardianus* Silv. (Hymenoptera : Eulophidae-Tetrastichinae).

Shipped from Hawaii, received from the Bureau of Entomology, Washington, U.S. America.

Host : *Ceratitis capitata* Wied. (Diptera : Trypaneidae).

Six parasites of each species were liberated in the Barrage orchards and the rest were used as stock for breeding purposes.

1935 (August). — *Microbracon lefroyi* Dudgeon and Gough (Hymenoptera : Braconidae).

Received from the Entomological Research Laboratory of Bohtak, Punjab, India.

Hosts : *Pectinophora gossypiella* Saund. (Lepidoptera : Gelechiidae), and *Earias insulana* Boisd. (Lepidoptera : Agrotidae-Acontiinae).

Liberated in the Behera Province and Alexandria. Established and still bred in the laboratory for control purposes.

1936 (January). — *Exochomus melanocephalus* Zoub. (=*nigromaculatus* Goeze) (Coleoptera : Coccinellidae).

Received from the Government Entomologist of the Union of South Africa.

Host : *Pseudococcus sacchari* Ckll. (Hemiptera-Homoptera : Coccidae).

Liberated at Sanabo (Assiut Province). Feeds also on several species of aphids. The colony died in November 1936 and thus few were liberated.

Exochomus melanocephalus Zoub. has been wrongly recorded from Egypt by G. Storey.

1936 (March). — *Telenomus nawaii* Ashm. (Hymenoptera : Scelionidae).

Received from the Department of Agriculture, Fiji Islands.

Hosts : *Prodenia litura* F. and *Laphygma exigua* Hübn. (Lepidoptera : Agrotidae-Zenobiinae), and *Agrotis ypsilon* Rott. (Lepidoptera : Agrotidae-Agrotinae).

Liberated at Kafr El-Sheikh, Giza, Sids, and other localities. Recovered, but not quite established, and still bred in the Laboratory.

1936 (April). — *Comperiella bifasciata* How. (Hymenoptera : Encyrtidae).

Obtained from the Citrus Experimental Station, Riverside, California, U.S. America.

Hosts : *Chrysomphalus ficus* Riley, and *Aonidiella aurantii* Mask. (Hemiptera-Homoptera : Coccidae).

Only ten parasites were liberated at Giza and no recoveries were made. The host appears to be the factor inhibiting reproduction of the parasite.

1936 (May). — *Opius humilis* Silv. and *Diachasma tryoni* Cam. (Hymenoptera : Braconidae), and *Tetrastichus giffardianus* Silv. (Hymenoptera : Eulophidae-Tetrastichinae).

Shipped by the Bureau of Entomology Parasite Laboratory, Hawaii, Honolulu.

Host : *Ceratitis capitata* Wied. (Diptera : Trypaneidae).

Liberated at the Barrage. *Tetrastichus giffardianus* and *Opius humilis* were recovered the second year. The first got established, but the latter disappeared.

1936 (September). — *Anagyrus* spec. and *Leptomastix* spec. (Hymenoptera : Encyrtidae).

Received from the Dept. van Economische Zaken Plantenziekten, Batavia, Java.

Hosts : *Pseudococcus filamentosus* Ckll., and *Phenacoccus hirsutus* Green (Hemiptera-Hemoptera : Coccidae).

Liberated at Giza, Alexandria, Mamoura, and Shebin El-Kom. Recoveries from previous liberations were made and releases on fresh zones were enacted.

1936 (November and December), and 1937 (January). — *Leis conformis* Boisd. (Coleoptera : Coccinellidae).

Supplied by the Council for Scientific and Industrial Research, Canberra, Austraila.

Hosts : Aphids and scale insects.

The sotck was used for breeding and biological studies, few were liberated.

1937 (January). — *Telenomus nawaii* Ashm. (Hymenoptera : Scelionidae).

Supplied by the Department of Agriculture, Fiji Islands.

Hosts : *Prodenia litura* F. and *Laphygma exigua* Hübn. (Lepidoptera : Agrotidae-Zenobiinae), and *Agrotis ypsilon* Rott. (Lepidoptera : Agrotidae-Agrotinae).

Liberated nearly all over Egypt. Still bred in the laboratory for further liberations.

1937 (May). — *Exochomus melanocephalus* Zoub. (Coleoptera : Coccinellidae).

Supplied by the Government Entomologist, Transvaal.

Hosts : Aphids, common mealy-bugs and others.

Another consignment was introduced to enforce the few alive individuals, but all arrived dead.

1937 (June). — *Chelonus blackburni* Cam. (Hymenoptera : Braconidae).

Texas, supplied by the U.S. America Presidio.

Hosts : *Pectinophora gossypiella* Saunders (Lepidoptera : Gelechiidae), and others.

Liberated nearly all over Egypt. It is still bred in the laboratory and no recoveries were made.

1937 (September). — *Achrysopophagus* spec. (Hymenoptera : Encyrtidae), and *Scymnus conformis* Jord. (Coleoptera : Coccinellidae).

Supplied by the Department van Econ. Zaken Plantenziekten, Java.

Host : *Phenacoccus hirsutus* Green (Hemiptera-Homoptera : Coccidae).

Liberated in Alexandria, Mamoura, and Giza. The species became established and doing marveelous work.

1937 (October). — *Cryptochaetum iceryae* Will. (Diptera : Cryptochaetidae).

Supplied by the Citrus Experimental Station, Riverside, U.S. America.

Host : *Icerya purchasi* Mask. (Hemiptera-Homoptera) : Coccidae).

Few parasites liberated in Cairo, Giza, and Alexandria. Recoveries made only from Alexandria.

1937 (November). — *Leis conformis* Boisd. (Coleoptera : Coccinellidae).

Supplied by the Council for Scientific and Industrial Research, Canberra, Australia.

Hosts : Aphids and scale insects.

Liberated in Cairo, Giza, Barrage, and Alexandria. Not yet established, feeds on mealy-bugs, but prefers aphids.

1938 (March). — *Exochomus melanocephalus* Zoub. (Coleoptera : Coccinellidae).

Supplied by the Government Entomologist, Union South Africa.

Hosts : Aphids and mealy-bugs.

Liberated nearly all over Egypt. Still being bred in the laboratory for annual distribution.

1938 (May). — *Opius tryoni* Cam. (Hymenoptera : Braconidae).

Supplied by the Bureau of Entomology Parasite Laboratory, Honolulu, Hawaii.

Host : *Ceratitis capitata* Wied. (Diptera : Trypaneidae).

Liberated at Barrage. Small members recovered and readily released in the fields.

1938 (June). — *Opius tryoni* Cam. (Hymenoptera : Braconidae).

Supplied by the Bureau of Entomology Parasite Laboratory, Honolulu, Hawaii.

Host : *Ceratitis capitata* Wied. (Diptera : Trypaneidae).
Liberated at Barrage. Not yet established.

1938 (July). — *Tetrastichus giffardianus* Silv. (Hymenoptera : Eulophidae-Tetrastichinae).
Supplied by the Bureau of Entomology Parasite Laboratory, Honolulu, Hawaii.
Host : *Ceratitis capitata* Wied. (Diptera : Trypaneidae).
All arrived dead.

1938 (October and November). — *Achrysopophagus* spec. (Hymenoptera : Encyrtidae), and *Scymnus conformis* Jord. (Coleoptera : Coccinellidae).
Supplied by the Institute of Plant diseases, Buitenzorg, Java.
Hosts : *Pseudococcus filamentosus* and *Phenacoccus hirsutus* Green (Hemiptera-Homoptera : Coccidae).
Liberated in Giza, Samalout, and Mataana. The parasite became established, while the beetle failed to do so.

1938-1939. — *Dasyscapus parvipennis* Gah. (Hymenoptera : Eulophidae).
Received from Gold Coast.
Host : *Thrips tabaci* Lind. (Thysanoptera).
The parasites died during the journey.

1939 (June and July). — *Actia nigritula* Mall. (Diptera : Tachinidae).
Received from Brisbane (Australia).
Host : *Prodenia litura* F. (Lepidoptera : Agrotidae-Zenobiinae).
Six consignments were liberated at Dokki and Gimmaiza, and in the Dakahliah and Behera Provinces. Not established.

1939 (July-September). — *Anagyrus* spec. and *Leptomastix* spec. (Hymenoptera : Encyrtidae), and *Scymnus* spec. (Coleoptera : Coccinellidae).
Supplied by the Institute of Plant diseases, Buitenzorg, Java.
Hosts : *Pseudococcus filamentosus* Ckll. and *Phenacoccus hirsutus* Green (Hemiptera-Homoptera : Coccidae).
Liberated at Helwan, Maadi, Toura, Shebin El-Kom. Became established, and almost every specimen collected is parasitized.

1939 (August). — *Actia nigritula* Mall. (Diptera : Tachinidae).
Received from Brisbane (Australia).
Host : *Prodenia litura* F. (Lepidoptera : Agrotidae-Zenobiinae).
Two consignments were liberated at Dessounes (Behera). Not established.

1939 (September), 1940 (February, November, and December), 1941 (January and October). — *Actia nigritula* Mall. (Diptera : Tachinidae), *Microplitis demolitor* Wilk. (Hymenoptera : Braconidae), and *Telenomus spodopterae* Dodd. (Hymenoptera : Scelionidae).

Actia nigritula and *Microplitis demolitor* were imported from Brisbane (Australia), while *Telenomus spodopterae* came from Batavia (Java).

Host : *Prodenia litura* F. (Lepidoptera : Agrotidae-Zenobiinae).

Liberated at the Barrage, Giza, Fayum, Girga, Kena, Alexandria, and nearly all over Egypt. No establishment, and still bred in the laboratory for further liberations.

1942 (June). — *Comperiella bifasciata* How. (Hymenoptera : Encyrtidae).

Supplied by the Citrus Experimental Station, Riverside, California, U.S. America.

Host : *Chrysomphalus ficus* Riley (Hemiptera-Homoptera : Coccidae).

Only a pair of parasites survived. Efforts were made to breed them, but failed.

BIBLIOGRAPHY

Alfieri, Anastase (1928) : The introduction of a parasite (*Microbracon kirkpatricki* Wilk.) of the Pink Bollworm into Egypt (*Bull. Soc. Roy. Entom. Egypte*, XII, pp. 52-56).

Kamal, Dr. M. (1935) : Recent advances in the Control of the Pink Bollworm by natural enemies (Proc. VIth Inter. Congress Entom., Madrid).

Kamal, Dr. M. (1936) : Recent advances in the Control of the Pink Bollworm (*Platyedra gossypiella* Saunders) by Natural Enemies (*Bull. Soc. Roy. Entom. Egypte*, XX, pp. 259-293).

Moursi, A.A. (1948) : Contributions to the knowledge of the Natural Enemies of Mealybugs (*Bull. Soc. Fouad I Ent.*, XXXII, pp. 1-40).

Storey, G. (1916) : List of Egyptian insects in the collection of the Ministry of Agriculture (Bulletin No. 5, Technical and Scientific Service (Entomological Section), Cairo, p. 23).

Willcocks, F.C. (1922) : A Survey of the more important economic insects and mites of Egypt (Bulletin No. 1, Technical Section, Sultanic Agricultural Society, Cairo, pp. 167-169).

Willcocks, F.C., and Bahgat, Said (1937) : The Insect and related pests of Egypt. — Vol. I, part 2 : Insects and Mites injurious to the Cotton Plant (Royal Agricultural Society, Cairo, pp. 668-669).

The Biological Control of the Cotton leaf-worm *(Prodenia litura* F.) in Egypt

(with 16 Tables, 1 Graph, and 1 Plate)

by Dr. MOHAMED KAMAL Bey,
Professor of Entomology, Faculty of Science, Farouk I University

CONTENTS

I. INTRODUCTION

The Cotton leaf-worm is one of the most serious pests in Egypt. It has become, therefore, exceedingly important to devise other control methods than the usual picking of cotton leaves bearing *Prodenia* egg-masses.

Chemical control through the use of arsenical compounds has been highly recommended by the Ministry of Agriculture for the last 20 years. But the writer has always been sceptical about its results, because its application requires careful consideration and a great deal of planning to avoid the damage to crops and animals and misuse of material. Anyhow, the application of arsenicals did not afford protection enough to crops against the various stages of the larvae, nor would it satisfy the farmers who anticipated

immediate results. However, it has been recently claimed that relief has been found in the application of the commercial product known as the cotton dust which is a mixture of DDT, gamaxane, sulfur, and talc powder (inert ingredient).

Although the percentage of kill was higher and its action much quicker than arsenicals, there are some points yet to be studied, as its effect on the natural enemies and its accumulative effect in the soil. Before the recommendation of any chemical material as insecticide, it is the consensus of opinion among entomologists to test the material under variable field and laboratory conditions to determine its usefulness and its relation with the other biotic factors that enter into the complexus of the environment. Any information given otherwise would be, I am afraid, premature; misleading and even harmful.

On the other hand, from an economic point of view, the chemical method is expensive for small holding farmers who compose the majority of the growers as it entains the purchase of costy equipments that should be handled with experienced labor. In addition, there is always a need for repetition of the operation which involves increasing expenditure for labor and material.

We must, therefore, devise methods that are simple and easy to handle, inexpensive and efficient, and which require less labor and little repetition. All these aspirations are answered in the biological method of control which is nature's ownself defence. It has the advantage of being permanent and once established requires no more additional expenses or treatments.

The Cotton leaf-worm, in my belief, is a very suitable example for a pest in which success is expected to tender the endeavors of the intellectual biological control worker. Such belief was the inspiring power for my colleagues and myself to start a biological programme in order to defeat the well-established pest.

II. THE INFLUENCE OF THE INDIGENOUS NATURAL ENEMIES

The abnormal numbers of the Cotton leaf-worm during the summer leave no doubt that the potential reproductive capacity of the pest is by far greater than that of the powerful forces of its natural checks combined. This excessive abundance of the insect year after year throws always the balance in favor of the Cotton leaf-worm. In order to analyse the insects' environment, I began to study the various local factors which compute the ecological nitch of the pest in several parts of the country. This study have indicated the presence of several important enemies that live at the expense of the Cotton leaf-worm, and which are composed of several local predators and parasites attacking the Cotton leaf-worm in its various stages of development. The former, however, are more significant than the latter. Their occurrance

and numbers are so markedly variable in the same locality and in successive seasons to the extent that made it so difficult to predict any outbreak of the pest or even the outcome of local infestations.

However, much data and information have been collected on this matter for almost six successive years comprising most of the unhappy times of the last World War. The objective of these investigations, therefore, is to present a correct record of a whole-time job devoted for the first time to such work in Egypt, to describe briefly the outstanding characteristics and methods of handling the species concerned, and finally to ascertain the importance of natural enemies as agents of control of the pest. I hope that the results from such investigation will favorably produce the practical aspects of the subject for those engaged in pest control in Egypt, and bring about a new field of research work for those who are interested in similar projects in other countries.

III. THE NATIVE PREDATORS

The role played by our local predators in the fight against the Cotton leaf-worm is very great indeed. They have been collectively found to produce an important reduction in the increase of the pest during the worst three months of infestation, i.e. from June to August. Predators feed on the eggs and young hatch, and have been repeatedly observed in some provinces of the Middle-Egypt and in Menoufia Province to be capable of riding many fields of early infestations.

In order to prove the efficacy of the predators, a series of experiments have been carried out, in which 100 egg-masses of *Prodenia* were marked and examined daily in each of the four experimental cotton plots representing variety of conditions, namely Sids, Dokki, Gimmaiza and Montazah. The experiment was conducted during the three important infestation months (June to August) and continued for six successive years. The results of these experiments indicate that the average percentage of predation in the eggs (whether whole or part) varies from 19 to 25 %, depending upon several variable factors, such as the relative number of predators found per acre, the condition of the soil (watered or dry), the growth of the cotton plant (dense foliage or sparce), the site of the field plot, the presence or absence of a nearby aphid infestation, the occurrence of ant nests, and finally the state of the egg-masses whether it is covered by fuzz or denude totally or partly of it.

With regards to the young hatch, however, it was rather difficult to keep precise records of their actual kill as they were liable to move away from the spot either through migration to interlacing branches of neighbouring plants or by hanging themselves to fine silk threads swung away by the action of the wind and thus carried to some distance far from the site

of the experiment. Nevertheless, we were able to trail several cases and secure data as precise as possible, which indicate that over 60 % of the young larvae disappeared after the second day and about 80 % of what was left disappaered at the end of the third day.

TABLE I

Percentage of eggs destroyed by predators

DATE (Year 1939)	LOCALITY	NUMBER OF MARKED EGG-MASSES	PERCENTAGE OF EGG HATCH	PERCENTAGE OF EGG PREDATION	REMARKS
5th May	Dokki	7	93	7	On cotton
1st June	Dokki	11	73	27	,,
15th ,,	Shebin El-Kom	27	30	70	,,
17th ,,	Gemeiza	20	35	65	,,
17th ,,	Montazah	30	65	35	Covered with fuzz
18th ,,	Dokki	20	50	50	
20th ,,	Kafr El-Sheikh	35	92	8	Covered with fuzz
22nd ,,	Montazah	20	80	20	
23rd ,,	Kafr El-Sheikh	9	95	5	Eggs in double layers
24th ,,	Gemeiza	27	55	45	
26th ,,	Montazah	20	80	20	
28th ,,	Sids	6	50	50	
AVERAGE........................			66.5	33.5	

TABLE II

Percentage of eggs destroyed by predators

DATE (Year 1940)	LOCALITY	NUMBER OF EGGS-MASSES		PERCENTAGE EGG HATCH		PERCENTAGE EGG PREDATION		REMARKS
		WITH FUZZ	NO FUZZ	WITH FUZZ	NO FUZZ	WITH FUZZ	NO FUZZ	
June	Dokki	6	9	100	80	—	20	On cotton and okra
,,	Gimeiza	29	13	62	29	38	71	On cotton
,,	Sids	13	8	57	45	43 } 43	55 } 61	On cotton
July	,,	7	3	57	33	43	67	
10th June	Shebin El-Kom	10	8	40	12	60	88	On cotton
26th ,,	,,	12	8	33	50	67 } 59	50 } 63	On peas
27th July	,,	8	4	50	50	50	50	On cabbage
12th June	Montazah	25	7	72	77	28 } 25.5	23	On cotton
7th July	,,	30	—	77	—	23	—	On cotton
AVERAGE..........................				61	47	39	53	

Analysis of data comprising the very young larval predation as well, shows that an average kill of 33.5 % is considered to be a very conservative estimate of the total effect of predators on the younger stages of the Cotton leaf-worm.

Tables I and II give data for each locality.

A summary of the comparative results from several experiments run on the same bases in the localities mentioned for the years 1940-1944 inclusive shows that the average percentage of egg-masses destroyed by predators was 31 in 1940, 28 in 1941, 22 in 1942, 25 in 1943, and 32 in 1944.

The results procured from the experiments can be summarised in the following :

(1) The hair covering on the egg-masses afford certain protection against predators.

(2) The highest percentage of predatism has been recorded from Gimmaiza and Shebin El-Kom. This result is found later to coincide with the total number of predators per acre.

(3) Some egg-masses neither hatched nor attacked by predators but appeared to be either parasitized or affected by climatic conditions.

The apparent high mortality of the eggs as expressed in the experiments above due to the action of predators, indicates that almost close to one-third of the population of the eggs are destroyed, hence the degree of infestation varies from year to year.

Since the Provinces of Southern Gharbia, Menufia, Qualubia and Giza harbor more predators than those of Middle-Egypt or in Northern and Western Delta, it has become easy to explain why actual damage is always considerably higher in the north.

There are also some other factors that account for this phenomenon, namely climatic conditions and the diversified system of farming in the four provinces. These differences call for a variable number of insect species and, accordingly, an increase in the number of natural enemies. Other reasons are also found in the richness of the soil, the liberal use of barn yard manure and the heavy application of fertilizers. Last but not least important are the early planting of cotton and the presence of large acreage of clover and corn which harbor the Cotton leaf-worm and act as breeding centres for the natural enemies.

The excessive number of Cotton leaf-worms during the worst three summer months has been found to be simultaneously encountered by an opposing increase in the number of predators to counteract this enormous abundance. Although, experimental evidences have shown beyond doubt that predators prove to be of considerable value in this connection, yet there is no single predator that we can reckon to be of constant greater economic importance in the reduction of the Cotton leaf-worm as this effect is due to the combined action of the various predators, such as the coccinellids, rove, carabids and other beetles, hemiptera, hymenoptera (wasps, ants), orthoptera (Mantidae), lace-wings and other neuroptera, spiders, etc.

IV. NUMBER OF PREDATORS PER ACRE

In concurrent with those tests, another series of experiments have been conducted at the four stations previously mentioned for the purpose of counting the number of each species of predator found in a plot of one kirat (1/24 of an acre) of cotton. The investigation was carried out during the years 1938-1943 inclusive. One kirat contains on the average, according to our standard system of cotton planting, about 1000 hills, and in each hill two cotton plants are left to grow. We used to take for our daily counts twenty hills scattered at random all over the one kirat plot. The number of counts has been taken three times a day, the first at 8 a.m., the second at noon 12.30 p.m., and the third at 5 p.m. This process was repeated once every two days, and the average number of predators per feddan (one acre) was figured out. From these counts we have noted that the collective number of the various beneficial species of insects found in one acre of cotton in May 1940 amounted to 785.745, in June to 220.800, in July to 156.336, and in August to 30.696.

This conglomeration of predators work together harmoniously to overcome the toll of the common enemy. The most marked are the Coccinellids which rank first, followed by the Staphylinids (rove beetles), after which come the Anthocorid bugs *Orius* (formerly *Triphleps*), and finally follow the other groups in their order of merit, such as the spiders, the lace-wings, and others.

Tables III and IV show the approximate number of each of the most important predators found in one kirat of cotton during the infestation period by the Cotton leaf-worm in various localities of the country and at different times of the season. The data presented in these Tables are plotted in Graph I.

To sum up the results, the writer records the following :

(1) Irrigation increases almost three times the number of natural enemies.

(2) High wind reduces their number and compel them to shelter in the soil.

(3) Aphids increase the number through the presence of honey-dew and offer more food for the predators.

(4) Insecticides, dusting or spraying, reduce markedly their numbers.

Shaking of infested cotton plants to reduce infestation by collecting the Cotton leaf-worm is highly detrimental to predators as shown in Table V.

From figures in Table V one can easily draw the following conclusions :

(1) The number of natural enemies reaches its maximum at optimum infestations especially when the larvae are in the first stadium, i.e. in the crawler stage.

TABLE III

Number of predators in one kirat of cotton

MONTH (Year 1939)	LOCALITY	TIME	COCCINELLA	CHILOMENES	SCYMNUS	PAEDERUS	CALOSOMA	MISCELLANEOUS BEETLES	ORIUS	CHRYSOPA	HYMENOPTERA	MANTIDAE	ORTHOPTERA	SPIDERS
June	Dokki	7 a.m.	810	—	2350	2175	—	—	4700	930	—	—	20	1420
»	»	»	430	—	—	4800	—	—	—	—	—	—	—	2390
»	»	5 p.m.	665	—	1700	2800	—	—	3600	—	—	—	—	1492
»	Gemeiza	»	1750	520	1665	900	—	—	1437	748	—	115	650	—
»	»	»	740	230	1550	1050	—	—	1235	—	—	104	47	—
»	»	»	825	390	1660	1100	—	—	1050	—	—	46	570	1300
»	Shebin El-Kom	»	2975	305	8500	11500	—	400	8300	2520	—	—	—	900
»	»	»	1650	—	4800	7000	—	—	4600	—	—	320	—	620
»	»	»	1400	110	5700	9125	—	650	5500	—	—	—	500	700
»	Montazah	»	267	30	—	650	—	—	50	—	—	—	750	—
»	»	»	151	—	—	1100	—	—	—	—	—	—	—	1100
»	»	»	203	25	—	1130	—	—	—	—	—	—	50	1130
»	Kafr El-Sheikh	»	165	75	104	104	—	—	—	172	—	—	—	156
»	»	»	98	40	48	35	—	—	—	—	—	—	—	—
»	»	»	119	22	86	48	—	—	—	—	—	—	—	25
»	Sids	»	172	—	70	350	—	—	395	—	—	22	370	200
»	»	»	47	—	50	640	—	45	290	65	—	—	330	245
»	»	»	82	—	128	1450	—	265	320	—	—	22	265	340
July	Dokki	»	349	—	576	8335	—	—	1216	1624	—	120	249	4407
»	»	»	262	—	315	4028	—	—	431	1190	—	—	135	2555
»	Gemeiza	»	1050	—	1365	5260	—	—	1411	1167	—	554	—	428
»	»	»	1066	—	1420	5210	—	—	1450	1053	—	670	—	562
»	»	»	202	—	800	4255	—	—	1533	1073	—	624	—	480
»	Shebin El-Kom	»	667	—	1741	4330	—	—	434	—	—	—	150	450
»	»	»	783	—	3416	4417	—	—	430	—	417	—	105	317
»	»	»	488	36	2517	6177	—	—	360	—	432	18	215	310
»	Montazah	»	140	—	40	903	—	—	30	—	50	74	—	33
»	»	»	207	—	50	990	—	—	40	—	46	90	—	72
»	»	»	198	—	35	1160	—	—	135	—	37	126	—	64
»	Kafr El-Sheikh	»	318	—	395	284	18	—	360	—	50	—	73	273
»	»	»	195	—	282	215	—	—	235	—	55	—	152	186
»	»	»	352	—	443	435	9	—	390	—	19	—	184	210
»	Sids	»	41	—	50	396	—	56	44	67	—	—	80	93
»	»	»	17	—	42	57	—	67	26	46	—	7	70	55
»	»	»	39	—	39	422	—	41	53	65	—	15	77	72
August	Gemeiza	»	349	—	611	536	—	—	625	292	—	—	350	245
»	»	»	325	—	519	398	—	—	452	223	—	—	289	291
»	»	»	339	—	508	380	—	—	552	228	—	—	319	182
»	Kafr El-Sheikh	»	124	—	198	71	100	—	250	27	—	—	4	156
»	»	»	45	—	121	23	10	—	167	—	—	—	2	63
»	»	»	112	—	121	24	35	—	167	17	—	—	3	63
»	Montazah	»	19	—	15	40	—	—	25	—	—	—	—	23
»	»	»	8	—	32	43	—	—	13	—	—	—	—	25
»	»	»	17	—	—	26	—	—	13	—	—	—	—	31
»	Dersounes (Behera)	»	68	—	131	95	—	—	75	—	100	—	—	621
»	»	»	80	—	99	125	—	—	42	—	600	—	—	492
»	»	»	140	—	140	120	—	—	53	—	275	—	—	712

TABLE IV

Variation in number of natural enemies per one kirat

LOCALITY	MONTH (Year 1942)	COCCINELLA	SCYMNUS	PAEDERUS	ORIUS	CHRYSOPA EGGS	CHRYSOPA LARVÆ	CHRYSOPA ADULTS	SPIDERS	CONDITION OF THE FIELD
Gemeiza	July	1950	617	2615	—	300	—	570	900	before irrigation.
»	»	3517	2117	5250	1655	517	—	1715	2017	after irrigation.
»	June	633	317	1185	—	215	50	885	100	mild weather.
»	»	417	—	350	—	170	35	270	215	high winds.
»	»	700	50	775	25	275	—	575	—	after first dusting with arsenicals.
»	»	1125	125	825	75	425	25	825	250	untreated.
»	»	200	—	375	—	75	—	225	50	after second dusting with arsenicals.
»	»	1850	725	3485	700	650	—	2750	2085	untreated.
Shebin El-Kom	»	370	135	1585	134	50	—	—	85	before irrigation.
»	»	735	735	2150	68	30	—	15	270	after irrigation.
»	»	150	50	85	17	85	—	17	170	no aphids.
»	»	500	250	385	200	170	70	70	50	aphid attack.
»	»	35	850	85	17	—	—	17	—	after spraying with nicotine.
»	»	250	270	250	185	—	—	115	135	untreated.
Sids	July	150	150	20	150	20	—	—	170	dry soil.
»	»	335	485	270	335	20	—	17	85	irrigated soil.
Montazah	end July	60	120	400	100	100	—	—	300	before shaking plants to collect caterpillars
»	»	20	—	220	40	—	—	—	140	after shaking plants to collect caterpillars

(2) The total number of predators varies in respect to the locality. The maximum number is reached in Shebin El-Kom, then in Gimmaiza, followed by El-Dokki. While the number of predators at Sids is less than that at Gimmaiza and Dokki, it is decidedly higher, in the early part of the

season than that at Montazah. Maximum numbers has been observed in the morning as well as in the evening and much less so at noon due naturally to the high summer heat which forces the predators to look for shelter in the soil or among dense weeds or neighbouring corn fields.

(3) Predators begin gradually to decrease in numbers in July, become insignificantly smaller in September and disappear from the cotton fields in October. This phenomenon corresponds exactly with the status of infestation in the field.

TABLE V

Number of predators found in one kirat after the shaking of cotton plants

LOCALITY (July 1940)	TIME	COCCINELLA	SCYMNUS	PAEDERUS	ORIUS	SPIDERS
	early morning	335	306	527	83	91
Giza	noon	320	385	455	150	75
	late evening	502	170	608	60	98

(4) Unfortunately, some of the most important species of these beneficial friends such as the Coccinellids and the Chrysopids have been found victims to a number of local secondary parasites which interfere with their good work and prevent their abundance over the pest. From available data at hand, which is given under each species concerned, I can state with certainty that this factor has, in many instances been a deterent one in limiting the good work of the natural enemies of the Cotton leaf-worm.

(5) There is still that disadvantageous tendency of *Coccinella undecimpunctata* to migrate in November in great numbers from the Nile Valley to their overwintering quarters in the Egyptian Western Oasis and in the mountain ranges of Southern Sinai and the Red Sea region. This migration takes place about the time when they are mostly needed to handle small sporadic infestations on minor crops other than cotton.

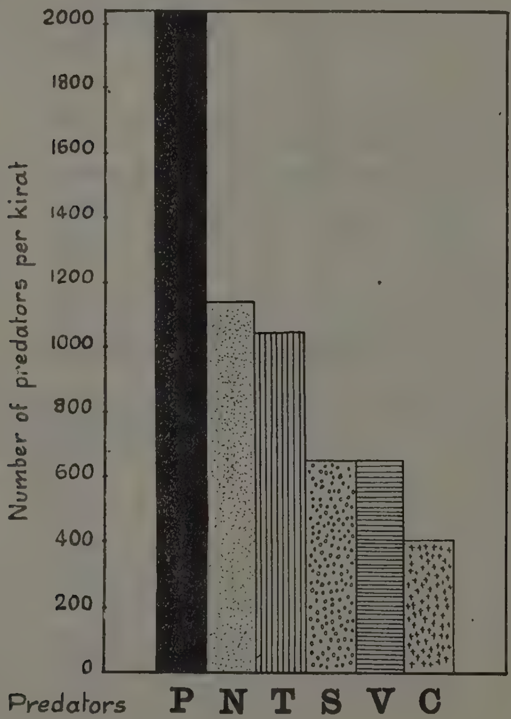
(6) Natural enemies seem to be severely affected by the application of insecticides, chiefly arsenicals and DDT compounds used as sprays or dusts against the *Prodenia* in the cotton fields. Experimental data from treated and untreated cotton fields at Gimmaiza, Kafr El-Sheikh and others demonstrate clearly that the numbers of these useful insects in treated fields drop down to almost half the original number before treatment. Some are found to escape by deserting the treated fields, while others succumb under the influence of the poison.

Some of the results are shown in Table VI.

Further tests carried in 1940 and 1941 substantiate the above results.

(7) Several egg-masses were marked in different parts of the cotton fields and left over for frequent daily observations. It was found that about 30 % of the egg-masses, especially those that contain little or no fuzz, were

Graph I



destroyed on the third day. Customary the farmers are used to hand-pick the egg-masses every day. According to the following data, they are advised to collect the eggs-masses once every three days in order to give a chance to the natural enemies to do their good work.

These experiments have been conducted in several localities and repeated for few years and the results obtained are summarised in Table VII.

The processes adopted in carrying out the experiments is as follows :

In the first kirat egg-masses are picked daily in the morning, in the second kirat every other day, in the third kirat every three days, and on the fourth kirat every three days and on the next day.

From the above figures, it can be easily seen that the number of egg-masses in case of picking every three days are less than one-fourth the number of eggs-masses picked every day which is apparently a criterion of the action of predators.

The results of similar experiments for the following years were as follows :

TABLE VI

Predators and chemical control

MONTH (Year 1939)	LOCALITY	COCCINELLA	CHILOMENES	SCYMNUS	PAEDERUS	CHRYSOPA	ORIUS	MANTIDS	HOPPERS (ORTHOPTERA)	SPIDERS	REMARKS
		COUNTS PER KIRAT									
28th June	Gemeiza	1140	800	3100	2900	2400	3900	22	2000	375	untreated
»	»	640	460	600	1260	900	660	—	840	180	treated
27th July	»	156	—	190	202	169	165	—	83	42	untreated
»	»	74	—	108	151	53	130	--	64	17	treated
		COUNTS PER FIFTY PLANTS									
6th July	Kafr El-Sheikh	14	—	47	16	3	17	—	11	6	untreated
»	»	—	—	2	2	—	3	—	6	3	treated
16th July	»	4	—	1	3	—	3	—	8	—	untreated
»	»	—	—	—	1	—	—	—	—	—	treated

First day 100 %, second day 56 %, third day 46 %, and fourth day 60 %, in 1941 ; first day 100 %, second day 62.6 %, third day 37 %, and fourth day 69.7 %, in 1942 ; first day 100 %, second day 71.8 %, third day 45.3 %, and fourth day 66.1 %, in 1943.

TABLE VII

Frequency of picking the egg-masses

LOCALITY	DATE (Year 1940)	NUMBER OF EGG-MASSES COLLECTED			
		FIRST KIRAT	SECOND KIRAT	THIRD KIRAT	FOURTH KIRAT
Sids	9th June	69	38	19	32
Dokki	16th June to 25th June	53	24	12	22
Shebin El-Kom.	9th June to 21st June	673	78	38	110
Gemeiza	12th June to 24th June	295	258	97	150
»	28th June to 10th July	92	54	25	50
Montazah......	10th June to 17th June	52	49	28	42
»	19th June to 26th June	73	73	46	58
»	28th June to 4th July	836	279	189	432
»	5th July to 19th July	339	310	114	178
»	31st July to 15th August	171	94	83	72
	TOTAL	2653	1257	651	1146
	PERCENTAGE...	100	47.5	24.6	43.1

The figures express the idea that in 1940 there were more predators in the field than in the years 1941-1943. This fact coincides with data given in Graph I.

V. THE VARIOUS INDIGENOUS PREDATORS STUDIED

Coleoptera

Coccinella undecimpunctata L.

It is the ladybird beetle most commonly met with all over Egypt from March till the end of October. The beetles and larvae proved to be very useful assets to Egyptian agriculture as they destroy large colonies of aphids, mealybugs, and *Prodemia* eggs and young larvae. Since the cotton plant is known to possess in the blossoms a large amount of glands which excrete nectar, and that a similar fluid is secreted from the glands in the midribs of the lower surfaces of the leaves, it has been observed that hordes of ladybird beetles, as well as other insects, gather on the cotton plants for this nectar.

Distribution, bionomics and feeding habits

In April and May, for instance, the beetles are more numerous in Upper- and Middle-Egypt, but as the temperature goes higher they begin to decrease in number by moving northwards. In the second half of July, the ladybird beetles become astonishingly rare in the cotton fields of the

TABLE VIII

Average number of Coccinella undecimpunctata L. *in cotton fields*

LOCALITY	NUMBER PER KIRAT IN JUNE	NUMBER PER KIRAT IN JULY	STAGE
Sids	646	184	adults
Dokki.........	447	75	»
Shebin El-Kom.	323	62	»
Gemeiza.......	1103	870	»
Montazah......	142	92	»
Mandara	379	—	pupæ

South and almost disappear there in August and September. They move North to orchards, corn (maize) fields, and hedge plants infested by aphids.

It is also worth recording that the immature forms of the insect disappear in summer all over the country and begin to show up in September accompanying the earliest infestations by *Aphis durantae* Theob., *Aphis gossypii* Glov., and *Aphis maidis* Fitch. During September and October, the insect again regains its status and resumes its activities in corn fields attacked by Aphids. Table VIII shows approximately the comparative

average number and occurrence of the various stages of *Coccinella undecimpunctata* L. in cotton fields in different localities during the two summer months.

Life-history

From Table VIII as well as from biologic studies on the predator, it was found out that the beetle has two distinct generations a year : the first one which begins in March in Upper-Egypt on Aphids attacking leguminous crops, and the second one in Lower-Egypt in the latter half of September. The insect passes the winter as adult, but in very few numbers in the Nile Valley and in greater amounts as previously stated outside the Nile valley, chiefly in the Libyan oasis on weeds and shrubberies infested by aphids and scale insects, and in the mountain ranges of Southern Sinai and the Red Sea.

Experiments have been conducted on confined beetles in the laboratory, fed on *Prodenia* eggs, for the purpose of studying their life-history and bionomics. The results of the tests carried on during September and October 1941, show clearly that a single female is able to lay as many as 130 eggs during her life-time, which lasted about 40 days. She began to lay 10-12 days after emergence, the whole life-cycle from egg to adult was completed in four weeks. Egg-laying ended nine days before her death, and the highest number laid at one time by one female reached 30, while the smallest was eight eggs.

The same experiment was repeated in February of next year at room temperature (20° C) and relative humidity 42 %. In this experiment, *Aphis durantae* Theob. replaced the *Prodenia* eggs and young larvae. The results obtained differ widely from the above. The egg-stage lasted from 4 to 5 days, the three larval stages lasted from 12 to 14, and the pupal from 6 to 8 days. The adults were kept alive for from 90 to 130 days. The highest number of eggs laid per female reached 512. On the average, 350 eggs are laid by a single female during its life-time which lasts for 95 days. But, in ordinary cases, it was found that the maximum number of eggs laid daily per female runs around 50 and the lowest number is 10. The female lays two or three egg-masses at intervals of few days, each mass consisting of a number varying between 8 to 20 eggs. In few cases it was observed that some females did not begin to lay until 30 days after their emergence.

It had been observed also that unmated females were capable of laying few eggs (5 to 7), but since these eggs were always infertile they became shrunken and collapsed.

Feeding records

When the adult ladybirds were confined in fruit jars containing wet cotton bolls and droplets of honey and were supplied daily with a certain

amount of food composed of *Prodenia* eggs and young larvae and also with duranta aphids, the amount and preference of food could be grasped from the daily consumption of food made by each stage of the predator as recorded in Table IX.

TABLE IX

Daily food consumption in the various stages of Coccinella undecimpunctata L.

STAGE OF THE PREDATOR	AVERAGE NUMBER OF EGGS	NUMBER OF PRODENIA LARVÆ CONSUMED						NUMBER OF APHIDS	MONTH
		YOUNG HATCH	ONE DAY OLD	TWO DAYS OLD	THREE DAYS OLD	FOUR DAYS OLD	FIVE DAYS OLD		
Adult	9	12	9	7	5	3	1	70	June and July
First stage larva	11	13	10	9	7	1	—	17	
Second stage larva	29	24	22	17	13	7	5	40	
Third stage larva	37	33	27	19	15	9	5	75	

The Table shows that the insect in feeding displays a preference towards aphids than to the *Prodenia*, and to the young hatch than to the eggs or advanced larval stages. The beetle larvae being more voracious than the adult is a fact that is clearly expressed in the figures given in Table IX.

The efficiency of the predator as agent of control.

It has not been clearly shown, until these investigations have been conducted, why should the multitudinous colonies of Coccinellids, at first found on early aphis infestations, and later on cotton attacked by *Prodenia*, be unable to cope with and check the rate of increase of the pest. The progress of these investigations, their extent to several regions in Egypt and their repetition for several seasons, made it possible for the writer to gather information that enabled him to throw some light on this complex problem. One of the chief causes for the inadequancy of this predator, lies in the fact that the adult beetles as well as their pupae are victims of hyper-parasites which hamper their activities and produce a marked reduction in their population.

To reach this conclusion, the writer had conducted several experiments extending during 1939-1944. They consisted of scouting and collecting large numbers of *Coccinella undecimpunctata* L. from the fields in various localities all over Egypt. The biggest possible number of beetle larvae and pupae were brought to the laboratory at all times. The objective ever since that discovery was to ascertain the species of secondary parasites, to acquire information regarding their distribution, their relationship to the various stages of the beetle, and finally their relative abundance and occurrence. On the basis of this accumulated knowledge, the writer has been able to record below the studies concerning each species of the secondary parasites.

Parasites

Dinocampus (Perilitus) coccinellae Schr.

This Braconid occurs throughout the country for it has been reared from specimens collected from Upper-Egypt on until further north to the Mediterranean coast. Its seasonal abundance coincides with that of the host. In May and June it is found in great numbers in Middle-Egypt (Sids), where the average parasitism may reach 13%. At Giza and Dokki, the percentage is 12%, which is very close to that at Sids, but in certain individual cases it reached as high as 50%. Near the coast and in the middle of the Delta, the percentage of attack has been recorded to vary from 9 to 20%, with an average of 11%. Gimmaiza and Dokki proved to be high centres for *Dinocampus coccinellae* Schr., followed by Shebin El-Kom and Montazah.

The percentage of parasitism as a whole appears to drop down somewhat in July and to rise up again in the latter half of August to resume its maximum rate during November and December when the population of the host reaches its lowest ebb.

Biology

It has been noticed that *Dinocampus coccinellae* Schr. oviposit in the last two ventral abdominal segments of the adult Coccinellid beetle and also in the pupa. The attacked beetle does not show any sign of discomfort or unrest, and feeds normally until almost a day or so before the emergence of the parasite larva, when suddenly the beetle ceases feeding, becomes inactive and motionless. Death does not follow immediately, but occurs a few hours after the issuance of the single full-grown parasite larva, which exits from the Coccinellid beetle through a round hole bored at the anal extremity of abdomen. The larva is yellowish in colour, legless, about 4 mm. in length, and changes to a pupa on the second day. The pupa builds a yellowish cocoon tinged with red which is fixed to the legs of the host. The adult Braconid parasite emerges after six days. It was noticed that females predominate. The life-cycle lasts from 3 to 4 weeks.

Tetrastichus coccinellae Kurdj.

This is another parasite that has been found to attack the pupae of *Coccinella undecimpunctata* L. It is very small, about 2 mm. in length, black in colour and very active. It emerges from a small hole bored on the dorsal surface of the host pupa, and several of these minute wasps, as many as nine emerge at one time. They began to issue two weeks after the pupae were collected from the field. Since the parasite has not been collected from many regions, but was reared from specimens collected from Giza,

Gimmaiza, and Montazah, it appears from its distribution that it occurs at least all over the Delta regions. From the few specimens from which the parasite was reared, it was not possible to give a correct data on the percentage of parasitism, but in the limited material at hand, it could be said that parasitism amounted to 10% in June at Montazah, and rose as high as 52% in November at Giza. This parasite presumably overwinters as pupa and begins to emerge in early spring.

Eupteromalus spec.

This is a small Pteromalid that may prove to be a new species, depending upon future identifications by Prof. Ferrière. It has been reared from the pupa of *Dinocampus coccinellae* Schr. From its habits it appears that this species is evidently a very useful hyper-parasite, as it killed about 8% of *Dinocampus* pupae in July 1943.

Other beneficial Coccinellids

Cidonia vicina nilotica Muls., and Cidonia vicina subsignata Pic

There are several varieties or biological races in Egypt belonging to this species, amongst which the yellowish var. *nilotica* Muls. and the black var. *subsignata* Pic are the commonest.

Both varieties are common in the cotton fields of Upper-Egypt and Lower-Egypt. Their numbers, although, much less than *Coccinella undecimpunctata* L., yet they compute occasionally a factor of some importance in the natural control against the Cotton leaf-worm.

The adults as well as the larvae are found to feed on the eggs and young *Prodemia* larvae up to four days old.

Scymnus (s. str.) interruptus Goeze, and Scymnus (Pullus) syriacus Mars.

There are several species of *Scymnus* found associated with the Cotton leaf-worm infestations in the fields. They are very abundant whenever an attack of aphids is found on the cotton or near by. They appear as early as April and May on aphids and mealy-bugs outbreaks on trees bordering the cotton fields of Upper-Egypt. In June and July their number decreases in the south due to their northward migration. Their average number per one kirat at their seasonal abundance in the Delta may reach 9000 individuals. They are useful predators on young hatch and are found hiding in hot summer days within the cotton squares or blossoms. On account of their small size and hiding habit, utmost care should be exercised in making the counts of their numbers in the field and in recording observations on their activities and feeding habits.

The Rove-beetle

Paederus alfierii Koch.

A very useful Staphylinid beetle that ranks second in importance to the Coccinellids.

This predator is common all over the cotton and corn fields of the country, particularly during the months of June and July when the average population may reach 58.000 individuals per acre.

The feeding capacity of the predator is very great indeed, as demonstrated in the experiments carried out for several seasons in the years 1940-1943. The beetles show a decided preference for young *Prodenia* larvae, which are either in the cluster stage or not more than two days old. In the absence of young larvae the predator died of starvation in the laboratory. If a mixture of *Prodenia* eggs and larvae are offered to the beetles as food, they prefer the second, and when these are exhausted they turn to the eggs. The amount of mixed food consumed by one individual beetle per day is estimated at 10-15 eggs and 10-20 young larvae.

Biology

It is really surprising to say that during the few years of field studies, it was not possible to come across any of the early stages of *Paederus alfierii* Koch. In the laboratory, the insect could be induced to lay its eggs in the soil containing some organic matter such as cattle dung or horse manure mixed with plenty plant detritus.

The egg is globular in shape, yellow-white in colour, about 3 mm. in length, and 1 mm. in diameter. It hatches within three days into delicate very active thysanuriform larva (Plate, fig. 1), which lives predaceously in the soil until it transforms to the adult stage.

Adults collected from Giza in June 1940 laid their eggs in November of the same year, while those collected from Gimmaiza in July laid their eggs in May of the next year. The adults can live for a few months in confinement, while some lived in the laboratory for one year. The females generally die within a few days after egg-laying.

From the foregoing study we can deduce that the early stages of *Paederus alfierii* Koch are subterranean in habits, and the adults arboreal. The beetles have one or at most two generations a year and they overwinter as adults in the clover fields.

The Rove-beetle parasite

Perilitus spec.

A large number of *Paederus alfierii* Koch were collected from Giza in July 1939 and were kept in separate glass vials for experimental purposes. Out of this number two individuals of an unidentified species of parasite,

that closely resemble the *Perilitus*, have issued out. The full grown larva of the parasite bores its exit hole at the anal part of the abdomen of the beetle, causing the immediate death of its host. The cocoon of *Perilitus* is pearly-white in colour, about 3 mm. in length, and is not fixed to the beetle, but found at a short distance from its host.

Carabidae

Calosoma chlorostictum chlorostictum Dej.

This Carabid beetle is widely distributed all over the country and is particularly abundant in the Behera Province. It is commonly met with in the cotton fields and is seen running swiftly on the soil shaded by the cotton plants. In some occasions individual beetles were found climbing the cotton plants looking for prey. The larvae on the contrary hide by day in cracks of the soil and become active at night to search for food.

Calosoma begin to appear in June and reach its maximum abundance in September. In October and November, it migrate from the cotton fields to clover and vegetable crops.

Biology and behaviour

Several adults and larvae have been collected from the field and brought to the laboratory for the study of their biology and feeding habits.

In confinement they are cannibalistic unless always supplied with surplus food.

One single adult beetle was found to destroy an average of 15 full grown *Prodenia* larvae and 20 of the fourth instar in one day. Some individuals, however, were able to consume 30-40 *Prodenia* larvae in 24 hours. The larval stage of the beetle, on the other hand, consumes about eight fully grown *Prodenia* caterpillars. Table X gives an idea of the feeding capacity of the beetles, and indicates the value of the *Calosoma* as predator.

TABLE X

Rate of daily feeding per Calosoma *beetle*

STAGE OF THE PREDATOR	NUMBER OF PRODENIA STAGES CONSUMED		
	FOURTH INSTAR	FULLY GROWN CATERPILLARS	PUPÆ
Adult beetle ...	30-40	20-25	5-7
Larva	10	10	none

Table X does not really represent the full feeding capacity of the predator as the beetles and larvae have not been raised from eggs in the laboratory, but were collected from the fields and thus the final results are undoubtedly liable to vary according to the age, aptitude and previous susceptibilities of the insect. Table X also shows that the pupae of the Cotton

leaf-worm are also susceptible to predatism by the beetles, while the larval stages of *Calosoma*, on the contrary, refused to feed on them, and in only very rare occasions they were compelled to do so if no other food was given.

Calosoma eggs are laid singly in damp soil about a few centimetres from the surface.

In November, the beetles ceased to feed and began to burrow tunnels in the soil where they hybernated until next spring, whence they emerged, and devoured all the cut-worms which were the only procurable food at that time. Consequently, there is only one generation a year.

Hemiptera

Orius (formerly *Triphleps*) *albidipennis* Reut. and *Orius laevigatus* Fieb., belonging to the hemipterous Anthocorid group, are of great economic value in destroying a large amount of eggs and young larvae of *Prodenia* (see Tables I-II, and Graph I). They rank third in importance as predators. Their population in cotton fields ranges on the average between 2500 to 3000 individuals per kirat, although in some cases their number may reach as high as 8000 to 9000. They replace almost all the other predators in Middle-Egypt, when the temperature during June and July seems to be unfavorable for them. They hide from the heat at noon in the squares and involucres and in the early morning or the evening they tend to resume their activities. Their feeding capacity is enormous. In captivity they are capable to destroy a mass composed of 100 eggs in 15-20 minutes by sucking the contents and leaving them as empty shells. They indiscriminately feed on *Prodenia* eggs-masses covered with fuzz or denuded of it, and on Cotton leaf-worms up to two days old.

Neuroptera

Chrysopa vulgaris Schn.

Chrysopids are very familiar predators in cotton and corn fields of Egypt, especially when the latter are infested with aphids. They are of great economic importance in the fight against the Cotton leaf-worm on account of the large numbers of eggs and young larvae which they are able to destroy. For this reason they fall in their order of merit next to the *Orius* (Anthocorid bug).

In June and July, lace-wings in all stages of development are seen in large numbers in the fields. In August, however, their numbers decrease in the cotton fields of the Delta, because they migrate to the corn crop infested with *Aphis maidis* Fitch, or to other crops such as beans and young cabbages, and also ornamental plants.

Feeding habits

Chrysopa vulgaris Schn. is primarily a feeder on plant-lice and mealy-bugs, but it is in the same time an important predator on the Cotton leaf-worm. Experimental data on the rate of feeding capacity indicate that the larva destroys a large number of *Prodenia* eggs amounting to 200-250 in 24 hours, and an average of 15-20 Cotton leaf-worms from 1 to 3 days' old have been consumed by one full grown *Chrysopa* larva in one day. It has been observed that the larvae are capable of destroying more food than they really require. This is usually done by causing punctures in the body of many preys as the predator runs fast along the host and stops only for a second to give the host a test with its two powerfully pointed fang-like mandibles.

However, there is generally a decided food preference for *Prodenia* egg-masses than young caterpillars in the cluster stage or from two to four days old. Table XI gives an idea of the food consumed by a single *Chrysopa vulgaris* Schn. during its four larval instars.

TABLE XI

Nature and amount of food consumed by Chrysopa

INSTAR OF THE PREDATOR	APHIDS	PRODENIA EGGS	PRODENIA CATERPILLARS NOT OVER TWO DAYS OLD
First larval instar . .	15-20	5	9-12
Second larval instar	28	35	16-20
Third larval instar.	100	150	40
Fourth larval instar	150	200-250	50

Life-history

Observations and data recorded herein are the results of several experiments in the field and in the laboratory conducted in different localities and at different times and seasons. Large numbers of eggs are seen deposited in June on cotton plants infested by *Prodenia*. Eggs are laid from 5 to 7 days after emergence of the adult *Chrysopa*. They hatch after 3 to 5 days depending upon the temperature. The first larval instar lasts from 3 to 4 days, the second 4 days, followed by the third and fourth instars. The fully grown larva usually seeks a secluded place where it spins a spherical cocoon of white silk in which pupation occurs. After 7 to 15 days, depending upon the temperature, the adult emerges. Therefore, the average life-cycle is generally completed in about 3 weeks. In November, in the laboratory at 21° C. it lasted from 4 to 5 weeks. The adults were kept alive in the laboratory on water and honey for 45 days. *Chrysopa vulgaris* Schn. has three to four generations a year and it overwinters as a pupa.

Parasites

Telenomus spec.

Scelionids are generally considered as primary egg-parasites of great economic importance. But our *Telenomus* spec. is detrimental since it attacks the eggs of the beneficial predator *Chrysopa vulgaris* Schn.

During June, *Chrysopa vulgaris* Schn. eggs can be seen in large number in cotton fields, but only few larvae seem to survive from this amount. Nevertheless, great numbers of eggs marked in the field or collected for rearing purposes in the laboratory failed to hatch. The average percentage unhatched or destroyed in the field during July was found to vary between 25 to 35 %, 8 % of which has been attributed to parasitism, a similar or a little less amount to predatism, while the rest is due to unknown causes. Similar phenomenon has also been observed to happen to the newly hatched larvae, great many of which perish as a result of cannibalism, a fact which is found to hold true for most young Chrysopids encountered in the field. In several instances, it was noticed that *Chrysopa* eggs are deposited on plants free from *Prodenia* infestation, thus larvae in such sites when they hatch undoubtedly perish from starvation.

TABLE XII

Percentage of egg mortality in Chrysopa

DATE	LOCALITY	NUMBER OF EGGS COLLECTED OR MARKED	NUMBER OF EGGS PARASITIZED	PERCENTAGE OF PARASITIZED EGGS		NUMBER OF EGGS HATCHED	PERCENTAGE OF EGGS HATCHED		NUMBER OF EGGS FAILED TO HATCH	PERCENTAGE OF EGGS THAT FAILED TO HATCH	
1940											
June.........	El-Dokki	160	—	—		100	60		60	40	
July	»	130	10	8		30	22		90	70	
»	Shebin El-Kom	180	—	—	8	150	83	60	30	17	30
»	Montazah	120	20	17		90	75		10	8	
November	Giza	120	30	25		60	50		30	25	
1941											
June.........	Sids	320	220	69		70	22		30	9	
»	»	500	20	4	25	430	86	62	50	10	13
July	Gemeiza	60	30	50		30	50		—	—	
»	Shebin El-Kom	350	40	11		240	69		70	20	
1942											
May	Sids	800	80	10		570	71		150	19	
June.........	Shebin El-Kom	430	100	23	13	258	60	69	72	17	18
»	Sids	370	30	8		279	76		61	16	
1943											
June.........	Sids	900	20	2		820	91		60	7	
July	»	300	—	—	3	290	97	88	10	3	9
»	Gemeiza	1950	90	5		1660	85		200	10	

Table XII gives an approximate percentage of egg mortality in various localities of the country and at different seasons.

Tetrastichus pubescens Nees

This is another parasite which had been reared from the pupae of *Chrysopa vulgaris* Schn. whose cocoons were collected in large numbers from the field. The parasite was observed to lay eggs in the fully grown *Chrysopa* larva. The attacked larvae show no sign of discomfort, and transform normally into the pupal stage, but instead of issuing adult lace-wings, a variable number (5 to 10) of small wasps emerges from each pupa. The parasite was reared only from specimens collected at Giza in November 1939. Experiments were carried out in the laboratory to ascertain its exact relationship with the host and it was found to breed easily only on the fully grown Chrysopid larvae. The parasite was able to complete its life-cycle in three weeks.

Ant lions

Helicomitus festivus Ramb. (Ascalaphidae)

The larvae of this neuropterous insect feed voraciously on the young and medium-sized caterpillars, which they prefer more so than the eggs, and are capable of destroying in captivity nearly 50 caterpillars from 3 to 6 days old in three minutes.

The seasonal appearance of this predator is rather queer. In June 1936 its sporadic outbreaks in enormous numbers in the field was recorded from almost all over Lower-Egypt, and this sudden occurrence was simultaneously coupled with a great reduction in the population of the Cotton leaf-worm in the regions where it was reported to occur in large numbers.

Arachnida (Spiders)

Attempts have been made to count the total number of all species of spiders in one acre field of cotton and it was found in Lower-Egypt, for example, that it runs on the average from 15 to 16 thousands individuals in June and July, and about 12 to 13 thousands during the same period in Middle-Egypt. It was found also that at Gemeiza, which appeared to offer optimum conditions, the population of the spiders reached the maximum number of 20.000 per acre. In August this amount drop down and it almost disappear from the cotton fields in October. Spiders are generally nocturnal in their habits and as most predators they appear to be, with but few exceptions, more numerous in the early morning and in the evening than at mid-day.

Few tests have been done on their feeding habits. One single female spider of the medium-sized species (*Chiracanthium isiacum* Cambr.), which is found in great number all over the country, *Ch. isiacum*, was kept in the laboratory alive for thirteen days and supplied daily with food. It was able to consume about 1177 *Prodenia* eggs before it died. The average food con-

sumption per individual, however, ranges between 32 of the first instar, 9 to 12 from 4 to 5 days old, and about 6 over five days old Cotton leaf-worms.

VI. THE INDIGENOUS PARASITES

From the preceeding discussion on the local predators we have seen that they are able to play an important role in combatting the Cotton leaf-worm.

The number of species of our indigenous parasites which have been reported to supplement the work of predators against the Cotton leaf-worm in Egypt, is astonishingly small, especially if we take into consideration the very long period ever since the Cotton leaf-worm had established itself into Egypt. Field observations and laboratory experiments showed that the parasites, as a whole, are unable to produce an appreciable effect on *Prodenia*, especially at the time of danger, i.e. during the highest activity of the pest in June, July and August. Accordingly, this indicates that the Cotton leaf-worm has entered Egypt free from its natural enemies which hold it in check in its original habitat.

As a result of long years of work, it was found that the local parasites of great economic importance are *Tachina larvarum* L. and *Actia palpalis* Will., both belonging to the Diptera Tachinidae.

Although, they appear late in the season, their effect on late generations of the Cotton leaf-worm is highly detrimental. They have been found to parasitize a large proportion of that brood that tend to hibernate in berseem fields. In this respect, they have proved their usefulness in the reduction of great numbers of the overwintering worms.

There is another important group of parasites belonging to Hymenoptera, but they rank second in importance to the Tachinid flies.

Diptera

Tachina larvarum L.

This Tachinid parasitic fly is widely distributed all over Egypt and begins to appear in few numbers in June and July. It reaches its máximum abundance during September-November.

Life-history

Females were bred in glass lamp chimneys covered with muslin at both ends and were offered honey and cotton balls half wet with water. They laid eggs easily in captivity, on almost any part of the host body, even on the prolegs and on such silly places like the wings of her mate. In some cases it was noticed that *Tachina* eggs were also deposited on the cotton leaves used as food for the subjected host larvae. These eggs were swallowed with the food.

As a result of a long series of experiments on oviposition, it was detected that the females require from 6 to 10 days on the average to begin egg-laying, but the maximum quota of eggs was not laid until the tenth day. The total number of eggs laid by one female during its life-time varied from 65 to 97 on the average, but in some cases, however, a maximum number of 78 was deposited in 24 hours.

Fresh Cotton leaf-worms were introduced to the female parasite every 24 hours until the fly died. The average longevity of the female ranged from 22 to 25 days (after emergence) and the actual oviposition period ran between 8 to 15 days.

Since one single *Tachina* maggot can cause the death of the host, it was advisable, therefore, to remove, with a fine brush wet with water, the supernumerary eggs laid on the Cotton leaf-worms and distribute them each on a single host larva. In this manner it was possible to produce every day a large number of parasitized host larvae. That was one of our methods used for mass-production of *Tachina larvarum* L.

Since the host larva is very aggressive when irritated, the possibility that the *Tachina* egg could be brushed off or the maggot crushed as it hatches, was not very unlikely to happen. Thus, the issuing young *Tachina* maggot, which usually begins to pierce the skin in its way to the internal body cavity, may fail to do so. Therefore, in order to nullify the larva to stop its aggresiveness, the host caterpillars were kept in a refrigerator for 2 days at a temperature of 4 to 6° C. Other caterpillars were dipped in hot water at 43° C. for only five minutes, and then placed between two blotting papers to prevent moisture which may produce infection.

The female parasites are found to display no special preference for any particular larval stage of the host for oviposition, but they have a slight tendency to chose larvae of about 18 days old. Less attention, however, was given by them to very young caterpillars. The parasitized host larva, shows no sign of discomfort but feeds normally until it transforms to the pupal stage. But instead of giving rise to the moth, a fully grown whitish maggot is seen to quit the pupae and move to the soil. After few hours it begins to transform into a reddish-brown puparium. In few cases some maggots are seen to carry their transformation within the host pupae. After a week or so in September, at an average laboratory temperature of 21° C, the adult flies begin to cut a round hole at one end of the puparium from which they emerge to feed and readily mate. The exact number of annual generations has not been clearly ascertained, but according to my studies and field observations it is not expected to be more than three or four, depending upon weather conditions.

Records from field collections supplemented by experimental data show that, regardless of the tendency of hyperparasitism on the part of the flies, only one parasite emerged in 83 % of the cases of parasitism, two in 17 % of the cases, and three in very rare occasions.

From the previous discussion on the prevalence of the parasite, it was noticed that the important Cotton leaf-worm brood, which causes serious damages to clover in May and to cotton in June and July, suffer very little by *Tachina larvarum* L. The greatest benefit, however, from this parasite is produced in September and October when its population is greater. Parasitism at this time may reach up to 50 or 60 % among the fall brood of Cotton leaf-worms which attack maize, peanuts, sweet potatoes, clover and broad beans. The population of the parasite and, consequently, its activities begin to slow down from the second half of November until almost the end of December when the fly enters into hybernation as a pupa.

Hyper-Parasites

Dirhinus giffardi Silv.

About a dozen puparia of *Tachina larvarum* L. were collected from the field at Gemeiza in October 1939. Out of eight of these, eight secondary parasites (hyper-parasites) emerged. They are very active wasps, about 8 mm. in length, shiny black in color with metallic sheen, and belonging to the Chalcid fly *Dirhinus giffardi* Silv. It remains to be known whether or not this hyper-parasite has other hosts in the country, and how far it spreads. The species is recognized to be a useful primary parasite of the fruit flies (Trypaneidae), and was introduced from West and South Africa into Italy, Hawaii and Puerto-Rico to combat *Ceratitis capitata* Wied. Furthermore, it was artificially bred in those localities on the puparia of *Musca domestica* L. Having now discovered this new record of its tendency to attack the puparia of a very useful tachinid fly, the situation of the parasite has become very perplexing, particularly in countries like Egypt where fruit flies are major pests.

Actia palpalis Will.

This is another very useful tachinid fly, small in size, much more numerous and more widely distributed in almost all the Provinces of the country than its allied *Tachina larvarum* L. Approximately, there is not a single lot of *Prodenia* caterpillars collected from the field in the fall which does not display a marked representation of that parasite.

Its activity begins from July and continues till the end of October, with maximum abundance at the end of August. Large numbers of Cotton leaf-warms varying in age from 10 to 15 days were collected in August 1943 from Dissouness (Behera), and after the lapse of ten days numerous *Actia* flies

issued. When figuring out the percentage of parasitism, it was found that it reached as high as 32. The fly is most discouraging to breed in confinement and repeated endeavours to induce the couples to mate and to breed was a failure. Therefore, all the data concerning its life-history is the result of observations made on material collected from the field.

The females are larviparous and deposit their maggots on Cotton leaf-worms at various stages of development varying from two days old to approximately sixteen. Older Cotton leaf-worms are not even spared, and their parasitization is of very rare occurrence. The second and third Cotton leaf-worms instars, however, are much more preferred by *Actia*. Cotton leaf-worms in the younger stages, which appear to be parasitized, have been ultimatily killed by *Actia* maggots, in spite of the fact that they may live for a few days after the emergence of the parasitic fly. On the other hand, if the Cotton leaf-worms are attacked in the older instars (fifth or sixth), they feed and develop normally without being affected by the internal parasitic maggot. In this case the fully grown *Actia* maggots pierce the skin of the Cotton leaf-worms and move away from the host to be transformed into the puparium. The host, being careless of this insignificant episode, carries on its normal development and issues later an adult moth. The issuance of *Actia* maggots from the host skin leaves no mark at all that can be seen by the naked eye. In August, the mature *Actia* maggots transform within two hours to puparia which give rise to adult flies after seven days. The missing link in the life-history of the parasite prevented the author from completing his studies on the biology of the embryonic development of the fly.

Eulimnerium xanthostoma (Grav.)

It is an Ichneumonid internal parasite which attacks many hosts other than the Cotton leaf-worm, chief among which are the cut-worms, *Agrotis ypsilon* Rott., and the lesser green-worm, *Laphygma exigua* Hb. It is quite common all over the country and appears in early spring (March) in Middle-Egypt (Beni-Suef) and Fayoum Provinces. At that time, it is able to kill an appreciable number of *Agrotis* and *Laphygma* caterpillars infesting berseem fields and early cotton seedlings. Later in the season, the parasite bridges over to *Prodenia litura* F. The parasite reaches its maximum population in the previous localities during April and May, then it aestivates until October.

The average percentage of parasitism was found to fluctuate between 5 to 7 on *Laphygma* at Fayoum Province during April and May 1939-1942, while in Imbaba (Giza) at the same period it rose up to 16%. With the advent of summer and the consequent rise in temperature in Upper- and Middle-Egypt, most parasites enter into aestivation, while some individuals

migrate North to the Delta region and carry on their activities on *Prodenia.*

The great system of perrenial irrigation and drainage in the Delta offers the appropriate temperature and humidity for the parasite to breed during the summer. In July, it was found to kill about 1% of the Cotton leaf-worms in the field at Giza, 2% at Dokki and Shubra, and about 3% at Shebin El-Kom. In October, however, the balance apparently is tipped in favor of the *Eulimnerium.* Its population suddenly rises after the elapse of the heat period and consequently the record of parasitism becomes higher. It reached 20% on cut-worms at Dokki in October 1940, and 14.5% on *Laphygma* at Sids during the same month in 1942. From the previous studies we can easily judge that the parasite is primarily an enemy of the cut-worms and army-worms and secondarily attacks the Cotton leaf-worm through bridging over until the two preferred hosts reappear in the fall.

The male *Eulimnerium* holds the female in copulation at least five minutes and the same female copulates several times with the same male. Eggs are kidney-shaped or bean-like in form, dark grey in color and hatch within two days. They are found within the body cavity of the host caterpillar. Sometimes as many as 36 eggs are counted in one caterpillar, but only one *Eulimnerium* larva survives and is capable of killing the host. The parasite larva swims freely in the visceral fluid and feeds on the internal organs for ten days until it reaches maturity. The mature larva is about 8 mm. in length, it permorates the host skin and leaves it to be transformed into a pupa within a white silken cocoon. The adult parasite emerged after 5 to 7 days and the female survived for 19 to 23 days feeding on honey droplets. The life-cycle from egg to adult lasted for 18 to 23 days.

Zele chlorophthalma (Nees) and Zele nigricornis Walk.

These two parasites resemble the *Eulimnerium* in its habits and behavior. They parasitize the Cotton leaf-worms as well as other Noctuids, such as *Agrotis ypsilon* Rott. and *Laphygma exigua* Hb.. *Zele chlorophthalma* (Nees) (Plate, fig. 2) and *Zele nigricornis* Walk. are widely distributed in Egypt and are bred from specimens collected from several localities, chiefly in Upper- and Middle-Egypt, from Assiut and Fayoum Provinces down to Giza.

Their seasonal abundance appear to be the same. They occur from March to May and again in October, with maximum activities in April and August. The percentage of parasitism in the Cotton leaf-worm varied considerably. In April 1942, at Fayoum, it was recorded to be from 4 to 10%; at Sids, in July 1941, it was 8%; in August 1942, at Giza, 7.5%; in November 1941, at Assiut, 6%. Parasitism in cut-worms, in November 1942, averaged 3.5%, while in *Laphygma* the average rose to 10% in Minya from specimens

collected in July, and in one single case in Minya we were able to record 80% parasitism on *Laphygma*.

Barylypa humeralis Brauns

(Plate, fig. 3)

Like the last two parasites, *Barylypa humeralis* Brauns is not specific on the Cotton leaf-worm but it attacks other hosts, amongst which are the cut-worms and the *Laphygma* caterpillars. The seasonal abundance of this parasite coincides exactly with that of the last two species. Field studies show that *Barylypa* is very common in April and May in Middle-Egypt attacking the Cotton leaf-worm in berseem fields and recording an average parasitism of 5%. In June, however, the population drops down and as a consequence the percentage of parasitism is much lower. At Fayoum and Sids it reached an average of 3% in April and May. In October and November, however, the population of the parasite increases enormously and its activities spread further north to Giza. During that time the effect of *Barylipa* on its hosts is markedly noted as demonstrated in the higher percentage of parasitism. In November 1941 at Giza 40% parasitism was recorded on the Cotton leaf-worm, and 13% on the cut-worm caterpillars from the same locality in October of the same year. The population of the parasite was noticeably lower in 1939, as only few parasitized specimens were collected in that year.

In studying the biology of the parasite, it was noted that the female prefers for oviposition the medium-sized caterpillars in the third instar. The eggs, which are laid inside the host, hatch within two days and the parasite larvae continue their development into the host pupae until they reach maturity wherein they pupate and emerge as adults. The life-cycle of *Barylypa* from egg to adult lasts for 4 to 5 weeks in June and July.

Trichogramma evanescens Westw. and Trichogramma minutum Riley

A very minute and delicate parasite adapted for biological control. *Trichogramma minutum* Riley is closely allied to our indigenous *Trichogramma evanescens* Westw. which is widely distributed all over the country where it parasitizes the eggs of the purple-lined borer of sugar-cane, *Chilo simplex* Butler. In captivity *Trichogramma evanescens* Westw. will breed in the eggs of the pink borer of sugar-cane, *Sesamia cretica* Led. and also in the eggs of the Cotton leaf-worm, *Prodenia litura* F. It has also been reared from *Prodenia* eggs collected from the fields during May and June but only on few occasions, particularly when the eggs were slightly covered or free from the fuzz protection. The life-cycle is extremely short and within 6 to 7 days a full generation is developed. Since lepidopterous eggs are generally known to

hatch within a short time, therefore, *Trichogramma* that breed within them and possessing a correspondingly short life-cycle, is, for this reason, very spectacular for mass production.

Chonomorium eremita Forst.

(Plate, fig. 4)

This Chalcid parasite breeds into the pupae of the Cotton leaf-worm. 10% of the pupae collected at Giza in 1939 were found to be parasitized by *Chonomorium* and about 36-54 parasites emerged from each pupa. The adult parasites are very active and copulate immediately after emergence. The larvae feed into the pupae or pre-pupae of *Prodenia* in which they also pupate. The pupal stage lasts for almost one week, after which the adults issue from a circular hole cut in the *Prodenia* pupa. The average percentage of parasitism by *Chonomorium* varies from 1 to 5.

VII. GENERAL CONCLUSION ON THE INDIGENOUS PREDATORS AND PARASITES

From the foregoing extensive work on collecting, rearing and examining Cotton leaf-worm material from various parts of the country, it was conclusively demonstrated that the local natural enemies as a whole are very useful assets in helping to destroy a good amount of Cotton leaf-worms, estimated approximately 32% during the summer months, and as high as 75% among the population of the winter brood.

Winters in Egypt are usually mild and sometimes quite warm to allow the Cotton leaf-worm to reproduce unchecked while hiding in the berseem fields. But our winters on the whole are cold enough to force most of the natural enemies to reduce their activities or enter into hibernation. As a result of this phenomenon, conditions become more favorable for an early start on the part of the pest. It has already been explained that *Prodenia* is more prolific than most of its enemies. Thus, it can multiply in enormous numbers in May and June, and by the virtue of this numerical abundance it is liable to gain an upper hand over its natural enemies.

From an analysis of accumulated data at hand, the majority of the parasites and several of the predators take much longer time to recover from the adverse winter conditions. In early spring it was shown that those that appeared early in March had to find a suitable intermediate host, such as *Agrotis* or *Laphygma*, to bridge over, but those that had no alternate host suffer heavy losses from early mortality.

Our local natural enemies, unfortunately, appear in considerable numbers late on the arena, i.e. after the Cotton leaf-worm has become very abundant in the field. This apparent insufficiency of our native natural enemies always

tips the balance in favor of the pest and of course to the disadvantage of the cotton growers. The rate of prolificacy of the pest is so high that unless the beneficial insects are sufficiently numerous at that time to break the undue abundance of the pest, no hope is expected in subduing the ravages of the pest.

For this reason, it has been tempted to try to overcome this seasonal irregularity between host and natural enemies by endeavouring to increase the efficiency of some of the natural enemies already present in the region. It was chosed for this trial some of the most promising ones which are easy to breed in confinement in enormous numbers, such as *Coccinella undecimpunctata* L. and *Trichogramma evanescens* Westw. These useful friends were continuously bred in the laboratory and periodically distributed in the field so as to force them if possible into a condition of permanent dominance over early infestation by the host. Such assistance given to these already established local natural enemies did not prove its feasability, nor did the partial reduction in the population of the pest in the experimental plots justify the time and labor.

The effectiveness of the local natural enemies was temporarily enhanced through liberations only in few occasions. But in most cases, however, this acceleration gave no practical results in the final reduction of the immense summer population of the Cotton leaf-worms, as good many of the natural enemies suffered serious set-backs from sudden adverse weather conditions.

We should not also forget to take into our consideration the previous information concerning the activities of the hyperparasites which, as a whole, were found to impair seriously the effectiveness of the natural enemies.

Consequently, the question of biological control has to be approached from a different and most promising prospective that should merit serious consideration if we desire to establish permanent check on the annual ravages of the Cotton leaf-worm in Egypt. The solution of the question lies in taking immediate action for introducing the parasites which prove to be of great value in keeping the pest under control in the chief cotton areas of the Western Hemisphere.

Prodenia in Egypt proved to lack a number of the most important parasites which prevent the insect from becoming a serious pest in other countries. It is, therefore, a duty to procure all the latest possible information on this problem. The initial scouting and contacting of fellow entomologists in other countries has been done by the author. Had it not been for the prevailing conditions at the time due to the World War, it is sure, the work would have greatly progressed. However, some very promising results have been achieved and those will be fully presented later in this paper.

VIII. THE STUDY OF EXOTIC PARASITES

General consideration

In 1938, the writer in agreement with the Director of the Entomological Section of the Ministry of Agriculture took the initiative to communicate with entomologists in countries where *Prodenia* occurs. After preliminary field investigations on its prevailing parasites have been made abroad, arrangements as to collecting and shipping have been discussed for the idea of introducing the most promising ones into Egypt. Contacts for this purpose have been established with Australia, Dutch East Indies, India, China, Japan, West and South Africa and the United States of America. These contacts culminated in providing us with significant information on the status of the *Prodenia* in these respective countries.

Through the courtesy of the Australian Government and the support of the Council for Scientific and Industrial Research, plans for the study of the *Prodenia* parasites were laid down. Such plans lasted a little over two years due to the troubles of the World War and its serious consequences on air transportation. During that time it was found advisable to appoint a junior entomologist in Queensland to take charge of the investigations on our behalf. Every possible assistance was afforded by the specialists there to carry out the research work in a successful manner. Important contributions have been accomplished that led to the introduction of a few species of parasites which will be discussed later.

Similar arrangements have been negociated with the specialists in the United States Bureau of Entomology, and through the generous cooperation of Dr. Clausen, chief of the Bureau, important knowledge has been given to us concerning the most important species of parasites.

The appropriation to start the research work in the U.S. of America was granted by our Ministry of Finance, but it was found almost impossible to carry on the proposed schedule due to the interference of war regulations. It is to be hoped, however, that with the U.S. of America post-war policy, it will be possible to resume our activities in realization of this very promising undertaking.

The past policy to introduce parasites from India and Indonesia should be started right away, as the frequent and fast air transportation service between our respective countries will actually make this attempt successful.

The writer's policy in trying to control the *Prodenia* is to introduce as many parasites as can for each stage of the pest. This, no doubt, will increase the opportunities for the biotic factors and enable them to play a significant part in checking the excessive summer population of the *Prodenia*.

Recent investigation of the problem of the Cotton leaf-worm in foreign countries disclosed two facts worthy to be mentioned. The first is that we must search in Australia and the neighbouring Pacific islands for important natural enemies of *Prodenia*, and the second is that we should not forget to look with greater hopes for final solution to this problem by sending a specialist to scout for parasites in the native habitat of *Prodenia*, such as California, where cotton is extensively grown. It may be very useful also to go as far down as Mexico, Central and South America, from where the genus *Prodenia* had first been reported by Linné. In this manner we will follow the same path along which *Prodenia* has travelled to get access to the East.

Since climatic conditions in the eastern coast belt of Australia are nearly similar to ours and since *Prodenia* exists there, it becomes important to investigate reasons why this pest is of insignificant importance in Australia.

The Australian project

It has been previously stated that *Prodenia* had bridged over from its native habitat to the Southern Pacific Islands and established itself in Australia. It is found now in the isolated Fiji Islands as well as in the coastal region of North Queensland, where cotton is grown. Reporting on the status of the *Prodenia* in Australia, our collaborator Miss Phyllis Robertson states that « practically all the material obtained from the field yielded parasites of several different species. Although, the degree of parasitism was not in general very great, its incidence in the early spring, when it should normally be at its lowest level, suggested that parasitic control might play a by no means insignificant part in the maintenance of low population levels in this country ».

Following to her inspection in the lucerne and beetroot fields infested by *Prodenia* Miss Roberston states that « the latter crops were irrigated and *Prodenia* had been recorded from this area in fairly large numbers during the previous Autumn. Its absence from what appeared a very promising collecting ground might possibly have been due to a heavy parasite attack in late Autumn ».

Investigations in Australia regarding *Prodenia* in Queensland indicate that the species is rarely observed, except in the fall, in any numbers in the field in the Brisbane area and the search for egg-masses has yielded no result. « In no case has attack by *Prodenia* reached the level of economic importance, and in general it has proved difficult to make collections large enough for parasitism records, as percentage of total parasitism has reached up to 66.6 % », said Miss Roberston in one of her reports.

The Director of the Institute for Scientific and Industrial Research states that "*Prodenia* is not a pest in Queensland. There are years on record where damage caused by this insect has reached proportions large enough to cause alarm". The reasons why *Prodenia* should occupy this position in Australia and yet be such a serious pest to cotton in Egypt are still not clear. Certainly parasitism does play a controlling factor, but there are other factors which need to be cleared, and the purpose of this paper is to throw some light on this long neglected problem.

It is realized that parasitic attack in the egg-masses and in the very early larval stages would probably prove most efficaceous in reducing the pest in Egypt.

In view of the above considerations attention has been concentrated on the field aspect of the investigation, supplemented by laboratory studies on behaviour, rearing, breeding and devising methods for receiving parasites from Australia.

IMPORTED PARASITES

Diptera

Actia nigritula Mall.

(Plate, fig. 5)

Techniques in shipping

The pupal stage appeared to be the one which could be most readily handled for transport. *Actia* flies at a laboratory temperature of 25° C. have been found to emerge within 6-10 days after the formation of the puparia. As 8-9 days have to be allowed between dispatch from Brisbane and arrival at the parasite laboratory in Giza, some provision have to be made for the emergence of flies en route.

Boxes of water-proof three ply wood were used. They measured 6 × 4 × 4 inches and were ventilated by small openings in two sides covered with fine mesh gauze. A corked hole in the lid was allowed for the removal of emerging flies on arrival. Each box was lined with cloth, and a rectangular celluloid food reservoir, packed with cotton wool soaked in weak sugar solution (8 %) was fitted in one end. The container is wrapped in damp sphagnum moss which proved to be better than cotton wool wrappings in maintaining humdity.

Actia puparia were attached at right angles to glued threads, so that the ends were free. Another method of attaching the puparia to the cloth lining of the container was with the use of casein glue. It appeared that the chief reason for the failure of the initial consignments to arrive in good

conditions was due to the liberal use of adhesive material for the fixing of the puparia.

Liberation and colonization

The total number of the fly puparia shipped to Egypt from Australia is estimated at 839 dispatched in six consignments from September 1939 until October 1941. Out of this number only 150 were liberated in the field and the rest perished in the boxes in transit either as puparia or as adults. A number died also in the laboratory.

Since it was found so difficult to breed *Actia nigritula* Mall. in confinement, it had to resort to direct liberation in the field in places approximately similar in climatic condition to its native habit, i.e. along the coastal regions of the Provinces of Behera, Gharbia and Dakahlia, in addition to two interior regions namely, Giza and Gemaiza.

Several years have to pass before it will be possible to predict whether *Actia nigritula* Mall. has become acclimatized or not. Those initial numbers liberated directly in the field are in fact too small for colonization, but chances may help them to breed and spread. The time factor in this respect is very important.

Hymenoptera

Microplitis demolitor Wilk.

This brachonid wasp although appears to be restricted in its activities in Australia, nevertheless, its importance cannot be overlooked. It can be considered a significant factor of control due to its high percentage of parasitism reported from various localities in Australia which may reach over 50 % along its range of distribution.

Biology

Microplitis demolitor Wilk. has been found to attack young Cotton leaf-worm in the first instars, i.e. before they grow to become destructive. It has never been possible to induce the parasite to accept Cotton leaf-worms of later instars nor would it accept an alternate host, and that was one of the draw-backs for its mass production. The parasite larva develops endoparasitically and when full grown it emerges when the host is half-grown, and forms a solitary cocoon at the posterior end of the Cotton leaf-worm.

The duration of the pupal stage of this parasite varies from 6 to 22 weeks during the winter. This suggests the occurrence of a diapause time in the life-cycle. The longest pupal period was recorded where cocoons were formed during those weeks in which the lowest temperatures prevailed. There is, therefore, a definite overwintering period which enables the parasite to withstand low winter temperature and preserves the species in a

resting stage. During that time *Prodenia* in Egpyt is also at its lowest population and is widely scattered in clover fields all over the country.

The life-cycle of *Microplitis demolitor* Wilk. is very short in summer as compared with that of *Prodenia*. A little over two generations of *Microplitis* breed through the equivalence to one generation of the host. The cycle in Egypt varied in length from 12 to 15 days during June to August.

In the laboratory, in October, the duration of the parasite egg + larval stages lasted from 6 to 9 days, and the pupal stage from 5 to 7 days. The minimum complete life-cycle lasted 9 days, the maximum 16 days, while in Australia it is 10 and 20 days respectively.

The reason for this variation in the length of the life-cycle can possibly be attributed to environmental factors such as temperature and humidity.

In Australia the maximum daily temperature in the laboratory in October ranged from 26 to 29° C, and high humidity conditions 75 to 80 % prevailed, while in Egypt the temperature prevailing in the laboratory during June-July of the same year was 3° C. higher, and humidity very much less, averaging around 45 %, usually accompanied by plenty of bright sun-shine.

The female *Microplitis* is rather prolific if supplied with food and kept under good care. As many as 95 progeny were recorded from one female. During that continuous breeding of female, a decided decrease in the number of fertile eggs was faced. That was later discovered to be the result of using males that were used to fertilize several different females.

Mating of adults

For breeding *Microplitis* it has become important to ensure proper copulation. It has been found that the temperature most suitable for mating lies between 29 to 32° C. Several methods have been experimented with in order to induce mating among the adults. Small breeding vials containing both sexes were exposed to strong light after separating the sexes as they emerge in separate individual containers for 24 hours. The above method was found the most successful and was reached at after several trials and errors. Males appear to suffer from what might be termed "odor fatigue" and thus remain quite obvious to the presence of female.

Rearing

The breeding of *Microplitis demolitor* Wilk. in large numbers through several generations in the insectary is necessary in order to reserve from each brood enough stock to continue production on the scale desired and to liberate the balance of the stock on selected field infestations. This procedure usually requires simultaneous breeding of the Cotton leaf-worm to procure the desirable stadium for parasitization. A method of breeding the

parasite in confinement has been developed and proved satisfactory for the purpose. Mated females have been confined with young *Prodenia* caterpillars in the cluster-stage in glass tubes 15 cms. long and 6 cms. in diameter. The tubes are open at one end which is covered by muslin held in place by rubber bands.

In these parasite cages the females *Microplitis* were provided with small balls of cotton previously soaked in water, together with tiny droplets of honey pored along the midrib of an oleander leaf. This form of food has been accepted by all parasites, and if kept fresh for several days and has not become sufficiently sticky to entangle the feeding *Microplitis*.

The periodic exposures of the host caterpillars have been timed according to the numbers and apparent activity of the female parasites. An attempt was made to regulate the exposures to obtain the correct parasitization and avoid the risk of losses due to hyperparasitism. This method has also the advantage of saving much time which would otherwise be wasted in breeding a large number of unparasitized material when parasitization drops too low. Any mortality among adult parasites was continually compensated for by the addition of newly emerged adults.

The parasitized Cotton leaf-worms are removed after six hours of exposure to fresh, each containing a small bundle of freshly cut clover with thick foliage. The bundles will keep fresh if their ends are dipped in small jars containing water. The young Cotton leaf-worms will feed on the clover for few days and then stop feeding due to the effect of the internal parasite. The unparasitized larvae should be watched and removed immediately otherwise they, on account of their cannibalistic habit, are likely to feed on the parasitized ones. The latter are removed and placed in glass vials for the formation of parasite cocoon, which should be kept each in a separate vial.

In winter, it was noticed that reproduction of the parasite under laboratory conditions had diminished rapidly to the extent that the stock decreased to a few remaining females which died for no accountable reason. Temperature proved to be the limiting factor for the multiplication of both parasite and host.

Liberation

In liberating *Microplitis demolitor* Wilk. on widely scattered cotton fields in the Northern littoral part of the Delta, where climatic conditions are approximately equivalent to those of the coastal region of Australia, some facts must be taken into consideration. The parasites should be mated, their vitality should not be reduced by distant transportation, and finally the proper combination of temperature and humidity should be observed.

Such conditions when carefully administered result in great reduction of mortality and provide adequate chances for establishment.

There is always that divergence of opinion among biologists as to the most desirable number of parasites that should be released at a single time under different field conditions. In the case of *Microplitis demolitor* Wilk., it must be admitted, releases were too small because of the time factor that took us to overcome difficulties involved in the course of shipping, breeding and providing suitable host material. Therefore, instead of being able to make releases of at least 100 individuals at a time, the stock at any disposal did not allow to liberate more than 20. The liberations evidently had to be restricted to some of the infested areas within the most important cotton growing districts in Northern Delta. Few specimens were also released near the laboratory at Giza for closer observations.

Establishment

It has been surprisingly observed that liberations have been followed by favorable results. The parasite in the first year has been recovered from specimens collected from some locations in the North where releases were made. Recovery of the parasite from the sites of liberation or from somewhat distant fields, has been reported to occur from few weeks to few months from the time of liberation. The non-occurrence of the parasite in next seasons indicates that the numbers liberated have been too small to produce any apparent increase in the population of the parasite, and thus the chances of recovery are very little.

It is noteworthy to point out that although *Microplitis* has not yet proved to have established itself in the country, it does not mean that conditions in Egypt prevent its permanent establishment, nor has it failed to be accounted upon as a very valuable factor in the control of the Cotton leaf-worm. The fact remains that, in biological control, many examples are well known in Egypt and abroad in which the establishment of introduced parasite species in a new locality has not occurred until after the lapse of several years from their initial liberation and hopes had to be given up.

Notwithstanding the few numbers liberated parasites in the vast cotton area of Northern Egypt, survey work should be done every season to procure data on the status of the parasite before final conclusions could be drawn. A very closely related species of *Microplitis* has been reared during July 1941 and 1944 from very young Cotton leaf-worms, collected from Alexandria region and Belkass where the parasite was released. Whether this species is the same or a different one it has not been verified yet. Consequently, no reason can be seen why the Australian *Microplitis* cannot be acclimatized

especially if it was not given it yet the full chances, and particularly if another related species exists already in Egypt.

The significance *Microplitis*

It has been demonstrated that the attacks of *Microplitis* are directed specially against the young Cotton leaf-worms, which in large population proved to be very vulnerable to any local parasite activity. Due to this habit, the members of the genus *Microplitis* are, therefore, considered to be of great economic importance in Egypt for the purpose of subduing the ravages of the Cotton leaf-worm while in the young stage and it turns out to be destructive.

The Australian species *Microplitis demolitor* Wilk. proved to possess a diapause, which allows the parasite to pass-over the winter safely, at which time the population of the Cotton leaf-worm often drops almost to a very insignificant number. The *Microplitis* also possesses an advantage over its host, due to the fact that two generations of the parasite correspond to one generation of *Prodenia*. The faster rate of multiplication makes the parasite produce bigger population which in due time may very likely out-number that of the host. The result of this competition may create a permanent dominance of the parasite. These chances of success are further enhanced by the gregarious habit of young *Prodenia* caterpillars which in such condition offer favorable opportunities for total parasitism.

For the reasons mentioned above *Microplitis* was given by the writer greater care for importation and was preferred over all other parasites discovered in Australia Seven shipments totalling 703 individuals were received during the period from December 1940 to October 1941, after which the investigation was, unfortunately, discontinued due to Australian participation in the World War and the consequent interruptions in the air-mail services.

Telenomus nawaii Ashm.

(Plate, figs. 6-8)

Mr. Simmonds, chief entomologist at Suva, Fiji Islands, wrote me about an egg parasite abundant in the island to the extent that few *Prodenia* egg-batches escape from parasitization. He recorded a percentage of parasitism as high as 80. The parasite is known as *Telenomus nawaii* Ashm. It is apparently common in Tahiti as well as in Hawaii, but in the latter locality the only records, I have been able to find, refer to parasitation on *Spodoptera*, although *Prodenia* is reported to exist there.

In April 1936 an attempt was made to introduce this parasité into Egypt. Through the courtesy of Mr. Simmonds and the authorities in New South Wales, few consignments of that egg parasite were relayed

from Fiji into Australia. They travelled by boat from Suva to New South Wales and from there by air-mail to Cairo.

Breeding technique

The parasites were dispatched as parasitized *Prodenia* egg-masses. They arrived earlier for our *Prodenia* season and it had to be tried several Noctuid eggs for breeding purposes. The host eggs which furnished a good material for mass production of the parasite were those of *Laphygma exigua* Hb. and *Agrotis ypsilon* Rott. When the parasite was reared on the eggs of the latter they gave better results and yielded more vigorous offspring than on the former. Therefore, methods have to be developed to secure cut-worm (*Agrotis*) eggs on large scale. This was only done by developing a system through which continuous supply of cut-worm moths was always available particularly during the winter and the spring, i.e. until *Prodenia* eggs became available in the summer.

The method consisted of ordinary cages made of wire gauze, about 80 meshes per one square centimeter mounted on wooden frame. The cage has a wooden bottom and a glass top and door, and measures 50 cms. hight and 30 cms. wide. Each cage was supplied with a glass fruit jar containing some water in which a bundle of clover was placed. A petri dish containing wet pad of cotton in addition to few balls dipped in 8% solution of cane-sugar were distributed in various parts of the cage. At night the cage was darkened from inside with black paper, all over the sides, door and top. A moderate number (15) of moths was introduced in the cage after being exposed to direct sun-shine for few minutes.

The moths lay most of their quota of eggs on the black paper, few may be laid on the cotton wool and balls and also on the clover leaves. These eggs are removed daily by the aid of a wet hair brush and then are stuck on paper discs which are cut into strips and placed in small glass tubes for parasitation. After being exposed to *Telonus nawaii* Ashm. for from 4 to 6 hours, the strips are removed and watched for two days for any unparasitized egg which may hatch to be immediately destroyed. The strips are then kept in the laboratory or in the incubator at a temperature of approximately 24 to 26° C. Within a period of seven days, the adult parasites are almost ready to emerge when they are placed in a cool thermos bottle to be taken for liberation in the field. The localities and years of releases are given hereunder.

Minia Province: Minia (1936) and Fashn (1940). — Beni-Suef Province: Sids (1936, 1939 and 1940). — Giza Province: Dokki; Giza and Marazik (1936), Marazik (1937), Dokki (1938), Dokki and Giza (1939 and 1940). — Kalioubia Province: Shalakan (1937), Barrage

and Sheer Island (1938 and 1939), Barrage (1940). — Menoufia Province : Shebin El-Kom and Mit Khalaf (1939), Shebin El-Kom (1940). — Sharkia Province : Fakous (1940). — Dakahlia Province : Faraskour (1936). — Gharbia Province : Gemeiza, Kafr El-Sheikh and Sherbin (1936), Gemeiza, Kafr El-Shiekh and Kafr El-Zayat (1938), Gemeiza and Kafr El-Shiekh (1939), Gemeiza (1940). — Behera Province : Ezbet Khourshed (1936), Edfina (1937), Dessounes (1939), Gabariss, Kom Zomran, Denshall (1940). — Alexandria : Mamoura (1936), Montazah, Mamoura (1938), Montazah, Nouzha, Siouf (1939), Montazah and Mandara (1940).

With an available supply of *Prodenia* eggs in the summer, from May to October, it was possible to breed the parasite in large numbers and to liberate it directly in the field. For this purpose temporary breeding stations have been installed in the farms of the Ministry of Agriculture. In this way it has been possible to raise over seven million parasites during the summer period of 1938-1940.

Table XIII gives the total number of parasites released in 1940.

TABLE XIII

MONTH	Sids	Giza	Dokki	Shebin El-Kom	Gemeiza	Montazah	TOTAL
April	—	200	—	—	—	—	200
May	—	25000	—	—	—	—	25000
June	177600	187500	60000	148900	84100	61500	719600
July	770000	82000	42000	165800	90800	280000	1430600
August	120000	125500	48000	—	—	177600	471100
September	—	13000	—	—	—	—	13000
October	—	8000	—	—	—	—	8000
TOTAL...	1067600	441200	150000	314700	174900	519100	2667500

2.466.900 adult parasites were liberated in 1938, 2.516.080 in 1939, and 988.100 in 1941. Figures for 1938 and 1939 show that the number of parasites released in these years is relatively very close to the number released in 1940.

The discontinuation of releases in September and October as shown in Table XIII was due to the scarity of egg-batches in the cotton fields. The releases at Giza were reared on *Prodenia* eggs raised from our breeding stock in the laboratory.

Liberation

The average daily temperature at the various field breeding stations ranged between 29 to 32° C, and the humidity from 45 to 50 %. The duration of the life-cycle of the parasite varied from 9 to 11 days. When the temperature dropped to 22° C the life-cycle extended to 19 to 22 days.

It has been also observed that the males emerged before the females.

The rate of mortality which appears to be higher in the males, is given in Table XIV. No food was given to the parasites.

TABLE XIV

AGE OT ADULT IN DAYS	PERCENTAGE OF DEAD FEMALES	PERCENTAGE OF DEAD MALES
1	2	53
2	13	32
3	30	1
4	26	5
5	13	3
6	10	—
7	6	—

Table XV gives an account of the behavior of *Telenomus nawaii* Ashm. in the various localities in which it has been released. It shows that a high percentage of the parasitized eggs are preyed upon by the predators due to the fact that the parasitized eggs remain much longer on the plants exposed to the action of the various predators than the non-parasitized ones which generally hatch within three days. It has been also noted that in the majority of cases 95 % of the eggs of the egg-mass have been attacked by the parasite and its potentialities will be discussed later.

TABLE XV

Percentage of eggs parasitized by Telenomus *and life-cycle of the parasite*

LOCALITY	DATE	NUMBER OF EGG-MASSES IN THE FIELD PLOT	NUMBER OF EGG-MASSES PARASITIZED	NUMBER OF EGG-MASSES ATTACKED BY PREDATORS	EGGS HATCHED	LIFE-CYCLE OF PARASITE IN DAYS	
						FIELD	LABORATORY
Sids	7th-18th July	39	23	3	13	13	10
»	15th-25th »	62	28	5	29	12	10
»	26th July-12th Aug.	93	51	2	40	14	10
Dokki	12th-13th June	19	7	9	3	13	12
»	20th June	17	6	10	1	13	11
»	22nd »	9	4	3	2	13	11
»	24th »	15	2	13	—	13	11
»	2nd July	6	4	2	—	12	10
Gemeiza	18th June	47	42	1	4	13	11
Montazah	25th »	10	2	3	5	15	13
»	26th »	15	2	4	9	15	13
»	27th »	20	—	6	14	15	13
»	28th »	20	—	7	13	15	13
»	29th »	15	4	6	5	15	13
»	6th July	30	7	11	12	15	13
»	7th »	21	3	15	3	15	13
»	9th »	50	6	30	14	15	13
»	10th »	40	12	23	5	15	13
»	11th »	30	6	16	8	15	13
»	12th »	12	4	3	5	15	13

Telenomus spodopterae Dodd.

(Plate, fig. 9)

Professor Van Der Goot, Director of the Institute for Plant Diseases at Buitenzorg, Batavia, informed me of the presence of an efficient parasite attacking egg-masses of *Prodenia litura* F. in the tobacco fields of Java. Arrangements, therefore, were made to introduce this parasite into Egypt, and in October 1940 the first consignment of *Telenomus spodopterae* Dodd. arrived at Giza in a very good condition.

From that time on, *Telenomus nawaii* Ashm. and *Telenomus spodopterae* Dodd., have been regulary bred and liberated in our cotton fields. Experiments on the possible utilization of the parasites as agents of control against *Prodenia* eggs have been tried under variable climatic conditions. The method employed for propagating this parasite is similar to that used for *Telenomus nawaii* Ashm., and the *Agrotis*, *Laphygma* and *Prodenia* have been used for that purpose.

Liberation

In the summer of 1941, it was possible to liberate almost half a million individuals of *Telenomus spodopterae* Dodd. in various localities such as Kafr El-Dawar, Gemeiza, Shebin El-Kom and Giza. From that year on, a plan for the propagation and distribution of both *Telenomus nawaii* Ashm. and *spodopterae* Dodd. was laid with the idea that each species had been devoted to specific localities for a study of efficacy and establishment. The following figures give approximately the total number of the two *Telenomus* species liberated in the cotton fields during the period from May to the end of August for three successive years : 1.451.900 individuals in 1941, 1.398.500 in 1942, and 1.194.200 in 1943.

If are added to the above, the numbers released in the years 1938-1941 the total liberations will reach almost twelve million parasites.

With that large number of both *Telenomus* liberated in various localities varying greatly in ecological conditions, it was expected to attain excellent results from trials. But, unfortunately, the outcome has not been really recompensating the endeavors.

Two methods have been followed in liberating the parasites : the direct method of control, and the indirect one. In the first method, the parasites are released on definite egg-masses in the cotton fields ; while in the other, the parasites are liberated haphazardly in the infested fields. In the first trial it was possible to procure results as high as 80 % control, with an average of 30 % from all localities. In the second test, the percentage has been rather disappointing as it has never exceeded 2 %.

We know that *Prodenia* egg-masses in cotton fields under ordinary conditions are always susceptible to heavy predation ; those that are not

preyed upon generally hatch after three days from deposition. In experimenting with *Telenomus*, the parasitized eggs, however, remain for a period varying from 12 to 15 days before the adult parasites can issue. Therefore, they remain for a very long period exposed to predatory attacks. The results of these experiments are summarised in Table XVI.

TABLE XVI

Liberation of Telenomus *(direct method of control)*

YEAR 1942					YEAR 1943					
DATE OF LIBERATION	NUMBER OF EGG MASSES LIBERATED UPON	NUMBER OF PARASITIZED EGG-MASSES THAT ISSUED THEIR PARASITES	NUMBER OF EGG-MASSES PREYED AFTER BEING PARASITIZED	NUMBER OF UNPARASITIZED EGG-MASSES WHICH HATCHED	DATE OF LIBERATION	LOCALITY	NUMBER OF EGG-MASSES LIBERATED UPON	NUMBER OF PARASITIZED EGG-MASSES THAT ISSUED THEIR PARASITES	NUMBER OF EGG-MASSES PREYED AFTER BEING PARASITIZED	NUMBER OF UNPARASITIZED EGG-MASSES WHICH HATCHED
3rd June	4	1	—	3	9th July	Montazah	8	1	2	5
4th »	5	2.5	0.5	2	12th »	»	20	5	13	2
5th »	3	1.5	0.5	1	14th »	»	20	8	7	5
6th »	2	1	—	1	16th »	»	10	2	4	4
7th »	4	2	—	2	18th »	»	20	6	7	7
14th »	5	2	—	3	28th »	»	20	4	13	3
15th »	3	1	—	2	15th Aug.	»	30	8	16	6
16th »	5	—	2	3						
18th »	2	—	—	2						
19th »	7	4	2	1						
20th »	10	7	2	1						
21th »	12	6	3	3						
22th »	10	5	—	5						
28th »	7	2	1	4						
3rd July	10	1	5	4						
4th »	5	2	1	1						
5th »	3	—	2	1						
6th »	4	2	1	1						
7th »	7	1	4	2						
9th »	5	—	4	1						
11th »	4	1	1	2						
12th »	4	3	1	—						
13th »	3	2	—	1						
TOTAL	124	48	30	46	TOTAL		128	34	62	32
AVERAGE		38.7	24.2	37.1	AVERAGE			26.6	48.4	25

From Tables XVI and XVII we can deduce the following results :

(1) About one-third to three quarters of the original egg-masses are parasitized by *Telenomus*, but only about one-third of that succeeds to develop and issues adults.

(2) From one-half to two-thirds of the parasitized egg have fallen victim to predatism.

(3) More than one-third of the original number of egg-masses found in the field plots hatched into young Cotton leaf-worms.

(4) The parasites have displayed a decided preference for freshly laid eggs. Those that are over 24 hours old, are slightly attacked and if parasitized they often do not develop parasites.

Conclusions

(1) *Telenomus* prove to be efficient agents of control on *Prodenia* through direct liberation on egg-masses.

(2) To get the best results form this method the parasites should be continuously reared and liberated in the infested fields during the summer. This, of course, entails the establishment of temporary insectaries in the heavily infested regions by *Prodenia.*

It must be confessed that the method may appear at first cumbersome and slow, but similar procedures have been followed by the California Citrus Growers for many years in combatting the citrus mealy-bug through the use of *Cryptolaemus* and *Coccobius*, and the walnut moth by using the egg-parasite *Trichogramma minutum* Riley. Similar methods are also adopted by British and Canadian farmers for the control of the Spruce Saw-fly and the Gypsy moth.

A question may be raised ! Can *Telenomus* survive and become established in Egypt, especially, when the population of the Cotton leaf-worm drops in winter to such insignificant number ? The writer believes that it is possible for the parasite to do so, due to the fact that *Laphygma* and *Agrotis* are quite common in our fields in winter and spring. Since the parasites are found to attack the eggs of those two species, they can bridges over during the critical period on those two hosts until *Prodenia* eggs become prevalent in the summer.

IX. PRECAUTIONS AND PROCEDURES IN HANDLING FOREIGN IMPORTATIONS

Egypt with its situation at the cross-roads of all nations, makes it susceptible to accidental introduction of exotic pests. Our mild climate and fertile soil help those foreign intruders to settle and spread all over the country as has happeneed in the case of the Pink Bollworm. Therefore, the methods of handling parasite importation should be developed to secure the highest possible degree of insurance against any accidental introduction of undesirable plant pests or any hyperparasites.

Problems which have arisen during my engagement on the introduction of foreign parasites into Egypt, ever since the establishment of the Parasite Laboratory at Giza in 1929, can be briefly summarised as follows :

(1) Consignments should only be opened in a special quarantine room fitted with fumigation facilities. The only active living useful parasites are permitted to be removed from it, while other live ones are killed before being discarded.

(2) The study of the optimum conditions of temperature and humidity favourable for shipping the parasites is necessary, also a knowledge of the effective degree for refrigeration if necessary. Temperature and humidity en route and speed in transit are important factors in helping to carry on successful importations. Storage compartments should be at temperatures between 8 to 10° C. For the preservation of humidity in the containers, the wooden boxes are encased in moistened sphagnum moss rather similar device.

(3) Consignments must be timed as to be received early in the season to be ready for liberation during the peak of infestation of the host in a large proportion of the infested territory.

(4) The emerging adults en route should be provided with food. In this respect the queen honey bee candy gave satisfactory results and prevented the trapping of adult insects.

(5) When delicate insects are transported it is advisable to cover the sides, top and bottom of the wooden container with muslin tacked to the wood. A small amount of excelsior is added to increase the roosting space in the container.

X. ACKNOWLEDGMENTS

The great bulk of the research work was carried out in the Parasite Laboratory of the Ministry of Agriculture when the author was in charge of it. Therefore, I am greatly indebted to my former staff who have spared no help to make the work successful. Worthy of mention among these enthusiastic collaborators are Doctor E.A. Moursi, at present agricultural adviser at the Egyptian Embassy of Washington, and Mostafa Hafez and M. Mahmoud Effendi, entomologists at the Parasite Laboratory at Giza.

To my junior assistants, I must admit the valuable field and laboratory services rendered by Abd El-Monem, M. Gouda and M. Kamel Effendis.

Due acknowledgement must be accorded to Prof. H. Priesner, former Director of the Entomological Section, Ministry of Agriculture, for his co-

operative spirit, continuous advice and helpful suggestions during the course of the work.

Last but not least, the writer would like to express his indebtedness and gratitude to Dr. A.J. Nicholson, the chief of the Division of Entomology, Commonwealth Scientific and Industrial Council, Canberra, Australia, for the great assistance which he has been kind enough to give by appointing Miss Phyllis Robertson to carry out the survey work and investigation of the *Prodenia* problem on our behalf in Australia. Miss Roberston has been quite careful and intellectual worker and assisted us in good many ways by studying the parasites of *Prodenia* in New South Wales. She has shipped several valuable consignments to Egypt, and through her enthusiasm the investigations in Australia were possibly carried out.

To my senior lecturer Dr. A.A. Soliman I feel very grateful for reading and correcting the manuscript.

XI. SUMMARY AND CONCLUSIONS

It is approximately eighty years now since the Cotton leaf-worm, *Prodenia litura* L., has found its way into Egypt and aroused with its destructive habits a general complaint among official circles.

Hand-picking of cotton leaves infested with egg-masses is practiced ever since 1879.

The use of insecticides has been administered in the last twenty years but on a limited scale. The purpose of its use however, is not to replace the hand-picking, but to act as an auxiliary especially in localities where labor is very short.

In a country like Egypt, poisonous substances dangerous to life should not be indiscriminately put in the hands of the farmers.

For this reason, the biological method of control has been introduced. Once a control is established through its use, it is permanent and cheap and requires no further handling or repetition, as the case with dusting or spraying.

From a Zoogeographical stand point, the cultivable part of Egypt can be likened to an area with the sea in the north and the desert in the East and West. Once an insect becomes established, it finds conditions most suitable for its integrity and distribution along the fertile Nile valley.

Prodenia litura F., a native of the Western Hemisphere, would have become a much more serious pest were it not for the mortality which helps to hold it in check. This mortality is due to the result of the total sum of various combinations of complex factors which fluctuate from one season to another, thus producing the apparent seasonal variation in the damages

brought about by that pest. These factors can be summarized in the following :

(1) The ecological factors, (2) the work of the predators, and (3) the work of the parasites.

The normal limitation in the distribution of the Cotton leaf-worm over Upper-Egypt is attributed chiefly to abiotic factors represented in the environment.

On the other hand, the biotic factors, which comprise the work of predators and parasites are really of great importance. The combined efforts of those natural enemies produce at least a mortality of 33 % of the *Prodenia* population. But, because they work unnoticed, their value is usually underestimated. The part played by the predators is by far much greater than that of the parasites. The latter are rather few in number and, although quite useful, affect very little the Cotton leaf-worm population.

It is true that the work of these beneficial insects is not noticed in the years when the Cotton leaf-worm is at its worst, but this work cannot be denied in the seasons in which the infestation is normal. Under the latter circumstances, reports indicate that very little control work is being done, and it is here that the predators and parasites take care of the infestation. In winter, fall and early spring, the Cotton leaf-worm breeds continuously in clover fields, and herein comes the work of the parasites which are reported to kill over 50 % of the caterpillars hidden in the dense clover foliage. Unfortunately, those useful insects fall victim to a number of hyperparasites which destroy considerable numbers by attacking them in the various stages of their development. For detailed information on the status and the biology of each species of predators and parasites, the reader is referred to the text.

It is realized that in the case of such a pest in which the population density is enormous and covers a wide range of territory, there is a great opportunity for the addition to the indigenous fauna a number of the well recognized beneficial parasites known to affect a good percentage of control on the *Prodenia* in other countries. It is quite possible under such circumstances that at least one of the introduced species may become established and turn out to be a very valuable factor in controlling the Cotton leaf-worm.

The writer believes that such contemplated project is not beyond realization.

Australia, Java, and the Fiji Islands, have contributed some very valuable additions to our parasite work against the *Prodenia* in the form of egg-parasites such as *Telenomus nawaii* Ashm. and *Telenomus spodopterae*

Dodd, and the *Prodenia* young caterpillars parasite *Microplitis demolitor* Wilk., which are now being bred annually in the Laboratory and released in the field.

There are still some further useful predators and parasites to be introduced from Australia, India, Indochina, Java and above all from America in which our hope is fostered as it is the recognized original home of *Prodenia litura* F.

From this brief review of the subject, fresh light is thrown on the possibility of controlling the Cotton leaf-worm by the biological method. The humble part carried out by the author during the past few years is nothing but laying the foundation stone for fellow workers to built the construction. I profoundly believe that the solution of the problem of the Cotton leaf-worm in Egypt lies in the biological method. The usefulness of chemical control cannot be ignored nor denied but the two must go together and one should supplement the other, instead of being done at the expense of the other.

PLATE

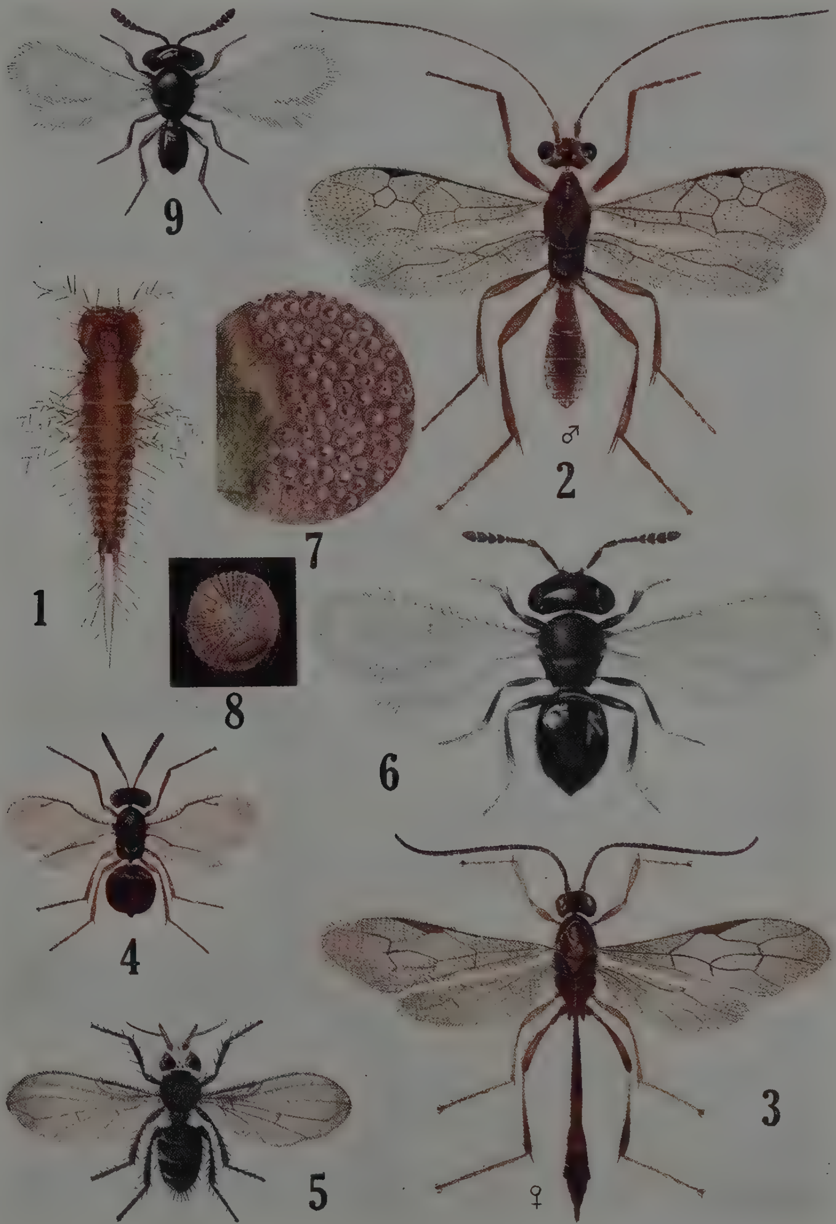
Explanation of Plate

Fig. 1: *Paederus alfierii* Koch, larva.
Fig. 2: *Zele chlorophthalma* (Nees) Hal., ♂.
Fig. 3: *Barylypa humeralis* Brauns, ♀.
Fig. 4: *Chonomorium eremita* Forst.
Fig. 5: *Actia nigritula* Mall.
Fig. 6: *Telenomus nawaii* Ashm., ♀.
Fig. 7: *Prodenia litura* F. egg-cluster parasitized by *Telenomus nawaii* Ashm.
Fig. 8: *Prodenia* egg after emergence of *Telenomus nawaii* Ashm.
Fig. 9: *Telenomus spodopterae* Dodd.

Biological Control of the Cotton leaf-worm in Egypt

Dr. Mohamed Kamal Bey

Plate



V. Siviter Smith & Co., Ltd.
Birmingham, England

New species of *Microvelia* from Egypt, with a key to the Egyptian Species of the Genus

[Hemiptera-Homoptera : Veliidae]

(with 9 Figures)

by Ludvik Hoberlandt,
National Museum, Department of Entomology, Praha

Through the kindness of Professor H. Priesner, Cairo, I have received for examination some Egyptian specimens of the genus *Microvelia* Westwood. These specimens belong to two species which so far have not been recorded for the fauna of Egypt, one of them represents a new species, which I describe below. The material examined is deposited in the collection of Professor H. Priesner and in the collection of the National Museum in Praha.

Microvelia (s. str.) waelbroecki Kirkaldy, 1900

1 ♂ and 1 ♀, macropterous forms : Meadi, Egypt, 23rd July and 6th August 1931, collected by H. Priesner.

This is the first record for the region of Egypt. This species was so far known only from the Lower Congo, the Ivory Coast, Nigeria and Belgian Congo (typical form). Form *mozambica* Poisson is recorded from Mozambique.

Microvelia (s. str.) priesneri sp. n.

Apterous male (fig. 1) : General colour black with pale brown markings on pronotum and venter, brownish antennae and legs. Head entirely black, eyes black, antennae brown with fuscous apices of first two joints, third joint fuscous on base as well as on apex ; fourth joint entirely fuscous. Rostrum brown, last rostral joint fuscous. Pronotum black with two pale brown spots near the anterior margin of pronotum. Metanotal lobes black.

Sternum blackish in lower part with brownish shade, margins of acetabula yellowish. Tergum, connexivum and venter black, only ventral side of connexivum and genital segments dark brownish. Legs brown, only coxae, trochanters and base of femora paler. Whole body, except the short velvety black tomentum, covered with dense long sub-erected golden and silvery shining pubescence; first three antennal joints, legs, head along the inner margins of eyes, anterior and lateral parts of pronotum, metanotal lobes, first and seventh abdominal segments as well as the genital segments with extremely long erect hairs.

Head nearly as long as wide across the eyes (32 : 34 [1]), vertex strongly convex, eyes small, only slightly exerted. Antennae stout (fig. 3), first antennal joint cylindrical, second joint towards the apex conspicuously widened, third joint only moderately widened and fourth joint fusiform, longest. Relative lengths of respective antennal joints I : II : III : IV : : 11 : 12 : 14 : 20. Pronotum by one fourth wider at base than long in the middle (40 : 28), towards the front moderately narrowed, lateral margins nearly straight, basal margin broadly rounded. Disc of the pronotum flattened, with scattered deep punctures, pale anterior spots bordered posteriorly with a row of similar punctures; pronotum in anterior two thirds with scarcely visible medial longitudinal carina. Metanotum visible as small triangular lateral lobes. Tergum towards the apex slightly narrowed, first to fourth tergite strongly deflected, fifth to seventh tergite horizontal and in the middle with longitudinal percurrent smooth and shining stripe; seventh tergite longest. Connexivum erected, exterior margin moderately rounded, basally rather straight.

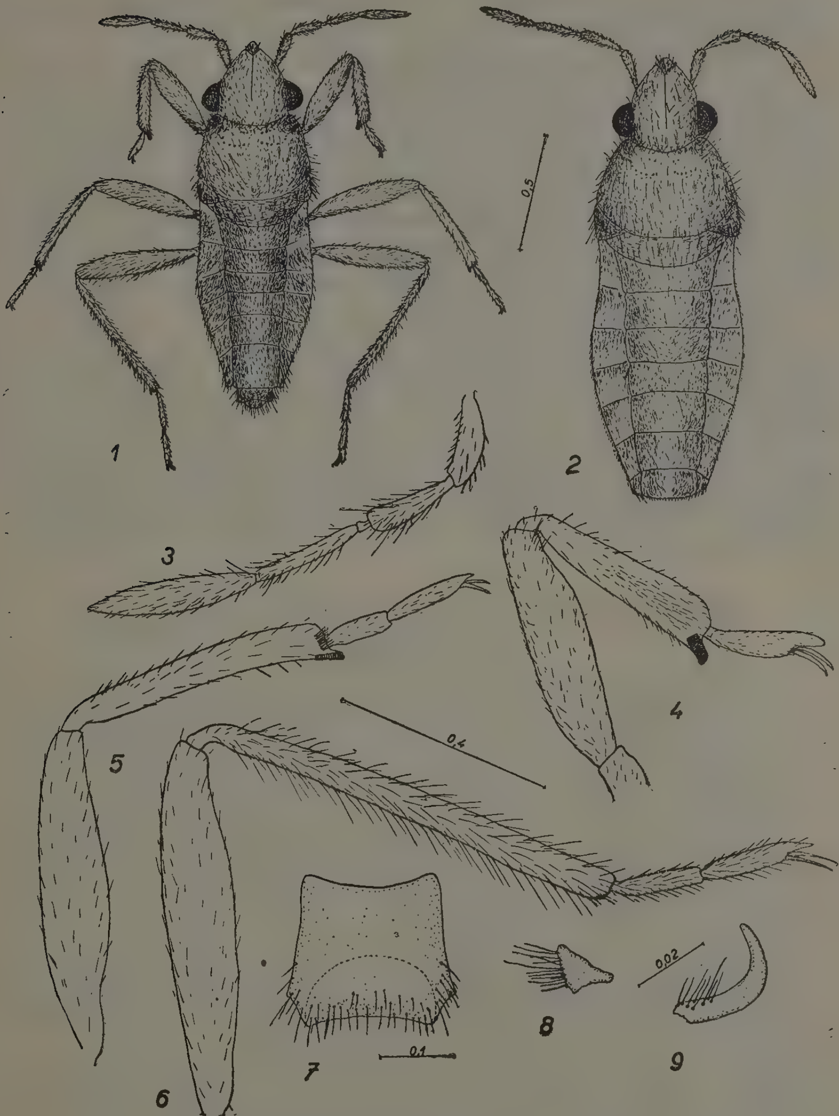
Legs (figs. 4, 5, and 6) slender, very long. Anterior femora swollen, tibiae towards the apex regularly widened and on the inner side ending in a stout spur with short straight row of pegs; middle femora regularly swollen; tibiae slightly sinuated, towards the apex moderately widened and on the inner side ending in a long spur with straight row of spine-like pegs; posterior legs very long and slender, straight.

Relative lengths of legs :

	FEMUR	TIBIA	TARSUS 1	TARSUS 2
Front	38	27	12	—
Middle . . .	37	35	8	11
Hind	46	53	11	13

Eighth abdominal segment (fig. 7) laterally before the apex with small tubercle and extremely long bristles. Right paramere (fig. 9) similar to

(1) One unit of relative measurements equalling 0,0123 mm.



Microvelia (s. str.) *priesneri* sp. n., apterous form :

Fig. 1 : General aspect of male. — Fig. 2 : General aspect of female. — Fig. 3 : Antenna of male. — Fig. 4 : Anterior leg of male. — Fig. 5 : Middle leg of male. — Fig. 6 : Hind leg of male. — Fig. 7 : Eighth abdominal segment. — Fig. 8 : Left paramere. — Fig. 9 : Right paramere.

those of *pygmaea*-group, but it seems to be rather bent in right angle. Left paramere (fig. 8) triangular.

Length : 1,48 mm. ; width : 0,49 mm.

Apterous female (fig. 2) : Size strikingly larger. In general colour similar to the male, only connexivum and abdomen rather brownish. Antennae in comparison with those of male rather slender and third joint rather less widened. Pronotal carina more distinct and reaches as far as the posterior margin of pronotum. Fifth to eighth tergites, which are horizontal as in male, with longitudinal shining line more distinct than this of male. Connexivum broad, raised, exterior margin rounded, basally sinuated. Legs very long and strikingly slender, linear.

Length : 1,99-2,07 mm. ; width : 0,64-0,66 mm.

1 ♂ (holotype) and 2 ♀♀ (allotype and paratype), apterous forms : Alexandria, North Egypt, 12th September 1933, collected by H. Priesner.

Closely allied to *M. gracillima* Reuter and *M. pygmaea* (Dufour), but differs from both in having different length of respective antennal joints and strongly widened second antennal joint, and relatively very long legs and rather long pubescence.

Key to the species of Microvelia Westwood from Egypt and adjacent regions

1. Antennae stout, first antennal joint long, extending by more than 2/3 of its length beyond the apex of head. Pronotum of apterous form long, covering mesonotum and metanotum for the most part; meso- and metanotum visible as small lateral lobes. Male parameres symmetrically developed; the comb of pegs on male anterior tibia occupying 1,7-1,8 of its length. ..... **Microvelia (Pseudovelia) major major Poisson**

— Antennae slender, first antennal joint short, extending by less than 1/2 of its length beyond the apex of head (*Microvelia* s.str.). 2

2. Pronotum of apterous form short; mesonotum uncovered, visible as a transversal stripe and metanotum visible as a triangular lobe or both meso- and metanotum visible only as lateral triangular lobes. Male parameres symmetrically developed. Body rather broad. 3

— Pronotum of apterous form long, covering mesonotum; metanotum visible as lateral triangular lobes. Male parameres asymmetrically developed : right sickle-shaped, left reduced. Body relatively narrow. 4

3. Mesonotum visible as a transversal stripe, metanotum as lateral triangular lobes. Fourth antennal joint 2-2,14 times longer than the first joint. .... **M. reticulata (Burmeister)**

— Meso- and metanotum visible as lateral triangular lobes. Fourth an-

tennal joint 1,8 times longer than the first joint. ....
.... **M. waelbroecki Kirkaldy**

4. Fourth antennal joint 1,8-2,15 times longer than the first joint. 5
— Fourth antennal joint 1,4-1,5 times longer than the first joint 6
5. Fourth antennal joint 2-2,15 longer than the first joint and distinctly longer than the second and third joints taken together. Legs of usual length. .... **M. gracillima Reuter**
— Fourth antennal joint 1,8 times longer than the first joint and distinctly shorter than second and third joints taken together. Legs unusually long. .... **M. priesneri sp. n.**
6. Abdomen in the middle of its length nearly as broad as the pronotum. Abdomen 1,5 times longer than its maximum width. Connexivum broad, plain, exterior margin rounded. Posterior margin of pronotum unicoloured, fuscous. .... **M. pygmaea Dufour**
— Abdomen narrower than the width of the pronotum, towards the apex distinctly narrowed. Abdomen twice together than its maximum width. Connexivum narrow, sub-erected, exterior margin straight. Posterior margin of pronotum pale. .... **M. hozari Hoberlandt**

Ein neuer *Sphodromerus* aus Aegypten

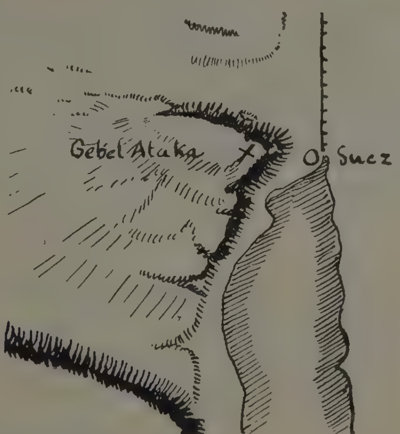
[Orthoptera : Acrididae]

(mit 2 Abbildungen)

von W Ramme (Berlin)

♀. Von mittlerer Grösse, ziemlich robust. Stirnleiste fein punktiert, ziemlich glänzend, oberhalb des Ocellus etwas verbreitert, unterhalb etwas eingeschnürt, dann die Seitenkanten divergent und zum Clypeus hin sich

1



2

Abb. 1 : *Sphodromerus atakanus* n. sp., ♀ (1 : 1). — Abb. 2 : Fundplatz (×) der neuen Art; Skizze des Sammlers.

auflösend. Scheitelgrube eingesenkt, mit, besonders nach hinten, scharfen Kanten, mit feinem Längskiel in der Mitte. Pronotum verhältnismässig lang, in ganzer Ausdehnung im Profil konvex, in der Pro- und Mesozona auch

seitlich etwas aufgeblasen, Vorderand in der Mitte etwas, Hinterrand stark vorgezogen, breit gerundet; Mittelkiel in der Pro- und Metazona schwach, aber deutlich, in der Mesozona kaum noch entwickelt; Rücken ohne Skulptur, stumpf, Seitenlappen der Pro- und Mesozona spärlich punktiert, der Metazona dicht und sehr fein runzlig. Mesozona etwas eingesenkt. Prosternalzapfen verhältnismässig lang, apikal stumpf abgerundet; Mesosternalgrube hoch rechtwinklig. Elytren breit langoval, sehr dicht innerviert, Präradialfeld absolut und relativ breiter als bei allen übrigen Arten. Hinterschenkel breit, wie in der Gattung blich, mit breiter Unterkante.

Gesamtfärbung einheitlich graubraun, auch der Elytren; Hinterflügel in ganzer Ausdehunng stark angeraucht, besonders im vorderen Sektor leicht gefenstert. Aussenseite der Hinterschenkel weisslich, bräunlich gegittert, Oberkante aussen von der Grundfärbung, Unterkante mehr grau; Innenseite, auch der Unterkante, schwarz, deren Rand weisslich. Aussenzeichnung der Knie wie bei *serapis* (vgl. U v a r o v, *Proc. Linn. Soc. London*, 1941-1942, 154:80, Fig. 3), jedoch das Schwarz auch noch auf die ganze vordere Aussenkante der Knielappen übergreifend; Hinterschienen und Hintertarsen einheitlich elfenbeinfarbig.

Die Art unterscheidet sich von allen übrigen durch die Breite der völlig einfarbigen Elytren (insbesondere des Präradialfeldes) sowie durch die fast in ganzer Ausdehnung geschwärzten, beziehungsweise angerauchten Hinterflügel.

Long. corp. 37; pronot. 10,6; elytr. 23,5; fem. post. 22; tib. post. 16,3 mm.

T y p u s ♀, Aegypten, Gebel Ataka, 17.XI.1947, C h r i s t i a n M ü h l n e r leg.

RESULTS OF THE ARMSTRONG COLLEGE EXPEDITION TO SIWA OASIS (LIBYAN DESERT), 1935, UNDER THE LEADERSHIP OF PROF. J. OMER-COOPER

Staphylinidae

[Coleoptera]

by MALCOLM CAMERON, M.B., R.N., F.R.E.S. (1)

OXYTELINAE

Trogophloeus (s. str.) cooperi sp. n.

Very closely allied to *memnonius* Er. but differing in the following respects : head and thorax less shining, more strongly coriaceous, the eyes a little smaller, the thorax much less distinctly punctured, the punctures scarcely visible and confused with the ground sculpture; puncturation of the elytra a little coarser and closer; in other respects similar to *memnonius* and with similarly constructed antennae. Length 2.5 mm.

Type : Zeitoun, 19-30.viii.1935, J. Omer-Cooper : Paratype : Khamissa, 29.v.1935, J. Omer-Cooper.

Trogophloeus (Taenosoma) desertus Koch

Trogophloeus (s. str.) *desertus* Koch 1936, *Pub. Mus. ent. Pietro Rossi*, 1 : 36.

Siwa, 22.vi.1935, J. Omer-Cooper, common, frequently at light.
Distribution : Egypt : Helwan ; Sinai : Tor.

Trogophloeus (Taenosoma) corticinus Er.

Gara, 3.vii.1935, 1 specimen; Siwa, abundant. Frequently at light.
Distribution : Holarctic region.

---

(1) The Manuscript and material of this Contribution were sent to the British Museum (Nat. Hist.) in 1939. Unfortunately the greater part of the material is believed to have been destroyed during the war when the Museum was damaged and very little of the material has been found. Only the specimens actually now existing are listed herein.

J. Balfour-Browne (1951)

Trogophloeus (Taenosoma) corticinus var. fulvipennis Fauv.

With the type form but less common.

Trogophloeus (Taenosoma) pusillus Grav.

Siwa, common.

Distribution : Europe, Mediterranean, Madeira, North America.

Trogophloeus (Taenosoma) halophilus var. simplicicollis Woll (2)

Siwa, 16-17.vii.1935, J. Omer-Cooper ; Zeitoun, 30.viii.1935, J. Omer-Cooper, 3 specimens ; El-Arig. Common.

Distribution : Madeira, Egypt, Sinai (?).

Bledius (s. str.) capra s. sp. seurati Peyerimh.

Siwa : Khamissa, one ♀.

Distribution : Tripolitania, Tunisia.

Bledius (s. str.) unicornis Germ.

Siwa, one ♂.

Distribution : Central Europe, Mediterranean, Canary Islands, Caucasus, Eritrea, Senegal.

Bledius (Elbidus) vitulus Er.

Siwa : Baharein, common ; Zeitoun 30.viii.1935, J. Omer-Cooper, 1 specimen ; Siwa Depression, 22.viii.1935, J. Omer-Cooper, 3 specimens.

Distribution : Arabia, North Africa, Spain, Senegal, Canary Islands.

Bledius (Elbidus) Kochi sp. n.

Closely allied to *vitulus* Er., the colour and lustre of the fore-parts very similar, but at once distinguished by the back abdomen, the thorax longer, less transverse, rather more shining, the punctures deeper and more numerous, in all other respects like *vitulus*. ♂ : unknown.

Type : Siwa, 1935, Dr. M. Cameron. Siwa : Three examples.

Bledius (Elbidus) angustus Rey

Common : Tenterad, 18.viii.1935, 6 specimens ; Siwa, 21-22.vii.1935, 1 specimen ; 31.vii.1935, 1 specimen ; Khamissa, 29.vi.1935, 1 specimen ; Khamissa, 5.viii.1935, 2 specimens.

Distribution : Western Mediterranean.

(2) Treated as valid species in Koch 1934, *Bull. Soc. Roy. ent. d'Egypte* 18 : 40 (Editor).

Thinobius (s. str.) aegyptiacus sp. nov.

Black, dull, the elytra brownish-black. Antennae reddish-yellow, the last three or four segments infuscate. Legs reddish-yellow. Length 1 mm. In lustre, sculpture and build much like *atomus* Fauv. but with the antennae more resembling those of *longipennis* Heer. Head narrower than the thorax, the eyes a little longer than the post-ocular region, strongly coriaceous. Antennae with the 3rd joint a little shorter than the 2nd, 4th to 7th about as long as broad, the 5th stouter than the 4th and 6th, 8th to 10th slightly transverse. Thorax nearly semi-circular, about a half broader than long, strongly coriaceous. Elytra twice as long as the thorax, strongly and roughly coriaceous. Abdomen with strong coriaceous sculpture as in *atomus* and with a short close, greyish pubescence as in that species.

Type: Sitra, Dr. M. Cameron; 14 paratypes, same particulars; Baharein; Shiata. Common.

Thinobius (s. str.) flavipennis sp. nov.

A little shinnig. Head and abdomen black, thorax reddish-brown, elytra clear yellow. Antennae and legs reddish-yellow, the former sometimes infuscate at the apex. Length 1.2 mm.

A very narrow fragile parallel species, about the size of *longipennis* Heer, but differing in the shape of the thorax, antennae and colour. Head as broad as the thorax, the eyes longer than the posterior region, scarcely bi-impressed in front, finely and very closely but indistinctly punctured, more coriaceous. Antennae rather short, the 3rd joint much shorter than the 2nd, 4th ot 10th all transverse, gradually increasing in width, the penultimate about twice as broad as long. Thorax scarcely transverse, widest in front, the sides almost straight and retracted backwards to the rounded posterior angles, the sculpture as on the head. Elytra longer (2.3 : 1.5) than the thorax, very finely, closely and distinctly punctured. Abdomen very slightly widened behind; very fine and closely punctured, more sparingly on the penultimate segments.

Type: Siwa, Dr. M. Cameron; Siwa, not common.

PAEDERINAE

Astenus nigromaculatus Motsch.

Siwa, Dr. M. Cameron, 2 specimens (six specimens).

Distribution: Egypt, Syria, Abyssinia, West Africa, Algiers, Spain, Corsica, Canary Islands.

Astenus melanurus Kust.

Siwa, 20-30.vi.1935, J. Omer-Cooper, 4 specimens, rather common.

Distribution : Mediterranean Region, Canary Islands, Abyssinia, South Africa, East Indies.

Medon (Lithocharis) ochracea Grav.

Siwa, two specimens.
Distribution : Cosmopolitan.

Scopaeus (s. str.) bicolor s. sp. kochi Bin.

Siwa, Dr. M. Cameron, 1 specimen (three specimens).
Distribution : Fezzan Oasis.

Scopaeus (s. str.) infirmus Er.

Siwa, Dr. M. Cameron, 7 specimens; Siwa, 1.viii.1935, J. Omer-Cooper, 1 specimen; Siwa, 6.viii.1935, 2 specimens; Khamissa, 5.viii.1935, J. Omer-Cooper, 4 specimens. Rather common.
Distribution : Egypt, Algeria.

Scopaeus (s. str.) debilis Hochh.

Siwa, 10.vii.1935, 2 specimens; 30.vii.1935, 1 specimen; 31.vii.1935, 2 specimens; 1.viii.1935, 1 specimen; 6.viii.1935, 13 specimens; 8.viii.1935, 16 specimens; 9.viii.1935, 4 specimens; 24.viii.1935, 2 specimens; 25.viii.1935, 1 specimen; Zeitoun, 30.viii.1935, 1 specimen. Common (all J. Omer-Cooper).
Distribution : Mediterranean Region.

Lathrobium macellum Fauvel

Siwa, 24.viii.1935, 1 specimen, J. Omer-Cooper.
Distribution : Algeria : Biskra; Egypt : Cairo (?).

STAPHYLININAE

Philonthus discoideus Grav.

Siwa, one specimen.
Distribution : Cosmopolitan.

Philonthus (Gabrius) thermarum Aubé

Siwa, 23.vii.1935, J. Omer-Cooper, 1 specimen. Common in manure heaps.

The thorax in these specimens, as in those from the Congo, is darker than in the type form.

Distribution : Cosmopolitan.

Cafius xantholoma Grav.

Mersa-Matruh, in seaweed.

Distribution : North and Central Europe, Mediterranean Region, Canary Islands.

Staphylinus (Tasgius) ater aegyptiacus Koch

Siwa, in manure.

Distribution : Egypt (Mex, Aboukir, Dekheila).

Heterothops brunneipennis Kiesw.

Siwa, Dr. M. Cameron, 3 specimens, common in manure heaps.

Distribution : Greece : Athens; Egypt, Tripolitania, Tunisia.

ALEOCHARINAE

Myllaena intermedia Er.

Siwa, El-Arig, common; Khamissa, Dr. M. Cameron, 2 specimens.

Distribution : Europe, North America, Australia.

Phytosus spinifer Curt.

Mersa-Matruh, seaweed, Dr. M. Cameron, 2 specimens.

Distribution : Western Europe, Western Mediterranean.

Heterota plumbea Waterh.

Mersa-Matruh, in seaweed.

Distribution : Western Europe, Dalmatia, Canary Islands.

Tomoglossa luteicornis var. laeta Epp.

Siwa.

Distribution : Europe, Northern Africa, Canary Islands, Caucasus, Japan.

Atheta (Metaxya) libyca sp. nov.

Moderately shining, head and abdomen black, the posterior margin of the last two segments of the latter reddish-yellow; thorax red or yellowish-red; elytra yellow, infuscate in the scutellar region. Antennae black, the first two joints reddish-yellow. Legs yellow. Length 2-2.3 mm.

A brightly colored species, in build much resembling *gemina* Aubé except for the shape of the head which more resembles that of *elongatula* Grav. Head transverse, sub-orbicular, narrower than the thorax, eyes mo-

derate, the disc sometimes with a feeble impression, very finely, sparingly punctured, distinctly coriaceous. Antennae slender, but slightly thickened towards the apex; the 2nd and 3rd segments of equal length; 4th to 10th all longer than broad, decreasing in length; the 9th and 10th only slightly longer than broad; the 11th fully as long as the two preceding together. Thorax a third broader than long, the sides gently rounded, along the middle with fine impressed line, as finely but more closely punctured than the head, the ground sculpture similar. Elytra as long as, but broader than the thorax, very finely, rather closely and somewhat roughly punctured. Abdomen a little narrowed before the apex, closely and finely punctured, less closely on the last two segments. Pubescence throughout fine, yellow and moderately close. Tibiae without setae. Male 8th dorsal segment nearly truncate, 6th ventral segment a little produced and broadly rounded.

Type: Koreishid, 30.vi.1935, J. Omer-Cooper; El-Arig, 8.vi.1935; Sitra. At the edge of brackish springs.

Atheta (s. str.) coriaria Kr.

Siwa, in manure heaps.

Distribution: Cosmopolitan.

Atheta (Acrotona) orbata Er.

Siwa, one specimen.

Distribution: Greenland, Iceland, Faroes, Great Britain, Scandinavia, Cyrenaica, West Africa, Hoggar Mountains.

Aleochara (Isochara) ebneri Scheerp.

Siwa, seven specimens.

Distribution: Palestine, Syria, Asia Minor, Turkestan.

TABLES DES MATIÈRES

DU TRENTE-CINQUIÈME VOLUME (1951)

Table des Espèces et Variétés Nouvelles décrites dans ce volume

(Les noms en italiques désignent les descriptions)

Coleoptera

Hemiptera

Hymenoptera

Orthoptera

PUBLICATIONS DE LA SOCIETE

Bulletins

Vol. I (1908-1909), Vol. II (1910-1911), Vol. III (1912-1913), Vol. IV (1914-1916), Vol. V (1917-1918), Vol. VI (1919-1921), Vol VII (1922-1923), Vol. VIII (1924), Vol. IX (1925), Vol. X (1926), Vol. XI (1927), Vol. XII (1928), Vol. XIII (1929), Vol. XIV (1930), Vol. XV (1931), Vol. XVI (1932), Vol. XVII (1933) et Vol. XVIII (1934) ... ... Epuisés

Vol. XIX (1935) ... ... P.Eg. 250
Vol. XX (1936) ... ... P.Eg. 250
Vol. XXI (1937) ... ... P.Eg. 200
Vol XXII (1938) ... ... P.Eg. 300
Vol. XXIII (1939) ... ... P.Eg. 300
Vol. XXIV (1940) ... ... P.Eg. 200
Vol. XXV (1941) ... ... P.Eg. 200
Vol. XXVI (1942) ... ... P.Eg. 150
Vol. XXVII (1943) ... ... P.Eg. 150
Vol. XXVIII (1944) ... ... P.Eg. 250
Vol. XXIX (1945) ... ... P.Eg. 300
Vol. XXX (1946) ... ... P.Eg. 150
Vol. XXXI (1947) ... ... P.Eg. 300
Vol. XXXII (1948) ... ... P.Eg. 300
Vol. XXXIII (1949) ... ... P.Eg. 300
Vol. XXXIV (1950) ... ... P.Eg. 250
Vol. XXXV (1951) ... ... P.Eg. 250

Mémoires

Vol. I (1908-1918), Vol. II (1922-1924) et Vol. III (1928-1929) Epuisés

Vol. IV { fascicule 1 (1930) ... ... Epuisé
fascicule 2 (1934) ... ... P.Eg. 200
fascicule 3 (1937) ... ... P.Eg. 200 }

Pour la correspondance administrative et scientifique, échanges de Publications, changement d'adresse et réclamations, s'adresser à Monsieur le Secrétaire Général de la Société Fouad Ier d'Entomologie, Boîte Postale N° 430, Le Caire.

العدد الخامس والثلاثون — السنة الرابعة والاربعون

مجلة
جمعية فؤاد الأول لعلم الحشرات

سابقا :
جمعية الحشرات المصرية (١٩٠٧ - ١٩٢١)
والجمعية الملكية المصرية لعلم الحشرات (١٩٢٢ - ١٩٣٧)

تأسست فى أول اغسطس سنة ١٩٠٧

وضعت تحت رعاية الحكومة المصرية بمرسوم ملكى
فى ١٥ مايو سنة ١٩٢٣

القاهرة
مطبعة بول باربيه

١٩٥١